SBIR
FY 2003
PROGRAM SOLICITATION

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NIST-03-SBIR

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology

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US DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

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PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.01 Introduction

The Department of Commerce (DOC) National Institute of Standards and Technology (NIST) invites small businesses to submit research proposals under this solicitation. Firms with strong research capabilities in any of the areas listed in Section 9 of this solicitation are encouraged to participate. **Unsolicited proposals are not accepted under the Small Business Innovation Research (SBIR) program**.

Objectives of this program include stimulating technological innovation in the private sector and strengthening the role of small business in meeting Federal research and development (R&D) needs. This program also seeks to increase the commercial application of innovations derived from Federal research and improve the return on investment from federally funded research for the economic benefit of the Nation.

1.02 Three-Phase Program

The "Small Business Research and Development Enhancement Act of 1992", as amended, requires the Department of Commerce to establish a three-phase SBIR program by reserving a percentage of its extramural R&D budget to be awarded to small business concerns for innovation research.

This document solicits Phase 1 proposals only.

NIST has the unilateral right to select SBIR research topics and awardees in both Phase 1 and Phase 2, and to make several or no awards under a given topic.

1.02.01 Phase 1 - Feasibility Research

The purpose of Phase 1 is to determine the technical feasibility of the proposed research and the quality of performance of the small business concern receiving an award. Therefore, the proposal should concentrate on research that will significantly contribute to proving the feasibility of the proposed research, a prerequisite to further support in Phase 2.

1.02.02 Phase 2 - Research and Development

Only firms that receive Phase 1 awards will be given the opportunity of submitting a Phase 2 proposal immediately following completion of Phase 1.

Phase 2 is the R&D or prototype development phase. It will require a comprehensive proposal outlining the research in detail. Further information regarding Phase 2 proposal requirements will be provided to all firms receiving Phase 1 awards.

1.02.03 Phase 3 - Commercialization

In Phase 3, it is intended that non-SBIR capital be used by the small business to pursue commercial applications of Phase 2.

1.03 Eligibility

Each organization submitting a proposal for both Phase I and Phase II **must** qualify as a small business concern (Section 2.10) for research or R&D purposes (Section 2.7) at the time of award. In addition, the primary employment of the principal investigator must be with the small business at the time of the award and during the conduct of the proposed research. More than one-half of the principal investigator's time must be spent with the small business for the period covered by the award. **Primary employment with a small business precludes full-time employment with another organization.**

Also, for both Phase 1 and Phase 2, the work must be performed in the United States. "United States" means the fifty states, the territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia. However, based on a rare and unique circumstance, for example, a supply or material or other item or project requirement that is not available in the United States, agencies may allow that particular portion of the R/R&D work to be performed or obtained in a country outside of the United States. Approval by the funding agreement officer after consultation with the agency SBIR Program Manager/Coordinator for each such specific condition must be in writing.

Joint ventures and limited partnerships are eligible, provided the entity created qualifies as a small business as defined in this solicitation. **Consultative arrangements between firms and universities or other non-profit organizations are encouraged, with the small business serving as the prime contractor.**

For Phase I, a minimum of two-thirds of the research and/or analytical effort must be performed by the awardee. For Phase II - a minimum of one-half of the research and/or analytical effort must be performed by the awardee.

Unsolicited proposals or proposals not responding to stated topics or subtopics are not eligible for SBIR awards.

Phase II proposals may be submitted only by Phase I awardees.

1.04 Contact with NIST

In the interest of competitive fairness, all oral or written communication with NIST concerning a specific technical topic or subtopic during the open solicitation period is prohibited - with the exception of the public discussion group located at www.nist.gov/sbir. Discussion group questions will be routed to the appropriate person for a response. All questions and responses will be publicly, though anonymously, posted on the discussion group web site.

Potential awardees may not participate in the selection of any topic or subtopic nor in the review of proposals. All proposers, including, Guest Researchers, contractors, Cooperative research and Development Agreement (CRADA) partners and others working with NIST may only submit a proposal if they:

Had no role in suggesting, developing, or reviewing the subtopic; and

Have not been the recipient of any information on the subtopic not available in the solicitation or other public means; and

Have not received any assistance from DOC in preparing the proposal (including any 'informal' reviews) prior to submission.

An Agency may not enter into, or continue an existing CRADA with an awardee on the subtopic of the award.

Requests for general information on the NIST SBIR program may be addressed to:

SBIR Program
100 Bureau Drive, Stop 2200
Gaithersburg, MD 20899-2200
Telephone: (301) 975-3085, Fax: (301) 548-0624
email: sbir@nist.gov

For information on contractual issues contact:

Susan Brinkman
Acquisitions and Logistics Division
Telephone: (301) 975-8007. Fax: (301) 975-8884
email: susan.brinkman@nist.gov

2.0 DEFINITIONS

2.01 Commercialization

This is locating or developing markets and producing and delivering products for sale (whether by the originating party or by others). As used here, commercialization includes both Government and private sector markets.

2.02 Essentially Equivalent Work.

This occurs when (1) substantially the same research is proposed for funding in more than one contract proposal or grant application submitted to the same Federal agency; (2) substantially the same research is submitted to two or more different Federal agencies for review and funding consideration; or (3) a specific research objective and the research design for accomplishing an objective are the same or closely related in two or more proposals or awards, regardless of the funding source.

2.03 Feasibility

The extent to which a project may be done practically and successfully.

2.04 Funding Agreement.

Any contract, grant, or cooperative agreement entered into between any Federal agency and any SBC for the performance of experimental, developmental, or research work, including products or services, funded in whole or in part by the Federal Government.

NIST will utilize contracts as the funding agreement for its SBIR awards.

2.05 Joint Venture

An association of persons or concerns with interests in any degree or proportion by way of contract, express or implied, consorting to engage in and carry out a single specific business venture for joint profit, for which purpose they combine their efforts, property, money, skill, or knowledge, but not on a continuing or permanent basis for conducting business generally. A joint venture is viewed as a business entity in determining power to control its management and is eligible under the SBIR and STTR Programs provided that the entity created qualifies as a "small business concern" as defined in this section of the policy directive.

2.06 Primary Employment

Primary employment means that more than one half of the principal investigator's time is spent in the employ of the small business concern. This requirement extends also to “leased” employees serving as the principal investigator. Primary employment with a small business concern precludes full time employment at another organization.

2.07Research or Research and Development

Any activity that is (a) a systematic, intensive study directed toward greater knowledge or understanding of the subject studied; (b) a systematic study directed specifically toward applying new knowledge to meet a recognized need; or (c) a systematic application of knowledge toward the production of useful materials, devices, services, or methods, and includes design, development, and improvement of prototypes and new processes to meet specific requirements.

In general, the NIST SBIR program will fund Phase 1 and 2 proposals with objectives that can be defined by (b) and (c) above.

2.08 SBIR Technical Data

All data generated during the performance of an SBIR award.

2.09 SBIR Technical Data Rights

The rights an SBC obtains in data generated during the performance of any SBIR Phase I, Phase II, or Phase III award that an awardee delivers to the Government during or upon completion of a Federally-funded project, and to which the Government receives a license.

2.10 Small Business Concern

A small business concern (SBC) is one that, at the time of award for Phase 1 and Phase 2:

(a) is organized for profit, with a place of business located in the United States, which operates primarily within the United States or which makes a significant contribution to the United States economy through payment of taxes or use of American products, materials or labor;
(b) is in the legal form of an individual proprietorship, partnership, limited liability company, corporation, joint venture, association, trust or cooperative, except that where the form is a joint venture, there can be no more than 49 percent participation by foreign business entities in the joint venture;
(c) is at least 51 percent owned and controlled by one or more individuals who are citizens of, or permanent resident aliens in, the United States, except in the case of a joint venture, where each entity to the venture must be 51 percent owned and controlled by one or more individuals who are citizens of, or permanent resident aliens in, the United States; and
(d) has, including its affiliates, not more than 500 employees.

2.11Socially and Economically Disadvantaged Small Business Concern

Is one that is:

(a) at least 51 percent owned by (1) an American Indian tribe or a native Hawaiian organization, or (2) one or more socially and economically disadvantaged individuals, and
(b) controlled by one or more such individuals in its management and daily business operations.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent Asian Americans, or any other individual found to be socially and economically disadvantaged by the Small Business Administration (SBA) pursuant to Section 8(a) of the Small Business Act, 15 US Code (U.S.C.) 637(a). See 13 CFR Part 124 -- 8(A) Business

Development/Small Disadvantaged Business Status Determinations, §§124.103 (Who is socially disadvantaged?) and 124.104 (Who is economically disadvantaged?).

2.12 Subcontract

This is any agreement, other than one involving an employer-employee relationship, entered into under a Federal Government funding agreement, calling for supplies or services required solely for the performance of the original funding agreement.

2.13 Women-Owned Small Business

A small business that is at least 51 percent owned by a woman or women who also control (meaning to exercise the power to make policy decisions) and operate (meaning being actively involved in the day-to-day management) the small business concern.

3.0 PROPOSAL PREPARATION

3.01 Proposal Requirements

The objective is to provide sufficient information to demonstrate that the proposed work represents a sound approach to the investigation of an important scientific or engineering innovation worthy of support. **The proposal must meet all the requirements of the subtopic in Section 9 to which it applies**.

A proposal must be self-contained and written with all the care and thoroughness of a scientific paper submitted for publication. It should indicate a thorough knowledge of the current status of research in the subtopic area addressed by the proposal. Each proposal should be checked carefully by the offeror to ensure inclusion of all essential material needed for a complete evaluation. The proposal will be peer reviewed as a scientific paper. All units of measurement should be in the metric system.

NIST reserves the right not to submit to technical review any proposal which it finds to have insufficient scientific and technical information, or one which fails to comply with the administrative procedures as outlined on the Checklist of Requirements in Section 8.04.

The proposal must not only be responsive to the specific NIST program interests described in Section 9 of the solicitation, but also serve as the basis for technological innovation leading to new commercial products, processes, or services that benefit the public. An organization may submit different proposals on different subtopics or different proposals on the same subtopic under this solicitation. When the proposed innovation applies to more than one subtopic, the offeror must choose that subtopic which is most relevant to the offeror's technical concept.

Proposals principally for the commercialization of proven concepts or for market research must not be submitted for Phase 1 funding, since such efforts are considered the responsibility of the private sector.

The proposal should be direct, concise, and informative. Promotional and other material not related to the project shall be omitted. **The Phase 1 proposal must provide a description of potential commercial applications.**

The complete proposal application must contain four copies of the following:

(a) Cover Sheet
(b) Project Summary
(c) Proposal Technical Content
(d) Proposed Budget

All signatures in each of the four copies MUST be ORIGINAL, i.e. no photocopies of signatures will be accepted.

3.02 Phase 1 Proposal Limitations

Page Length - **no more than 25 pages**, consecutively numbered, including the cover sheet (2 pages count as one), project summary, main text, references, resumes, any other enclosures or attachments, and the proposal summary budget.

Paper Size - must be 21.6 cm X 27.9 cm (8 ½" X 11").

Print Size - **must be easy to read with a fixed pitch font of 12 or fewer characters per inch or proportionally spaced font of point size 10 or larger with no more than 6 lines per inch.**

Supplementary material, revisions, substitutions, audio or video tapes, or computer floppy disks will **not** be accepted.

Do not use special bindings or covers on proposals submitted in response to this program solicitation. Staple all pages together securely in the upper left-hand corner of each copy of each proposal.

The original and all copies of each proposal should be mailed in one package.

Proposals not meeting these requirements will be returned without review.

3.03 Phase 1 Proposal Format

A complete proposal application must include four copies of each of the following:

Proposal Cover Sheet, Project Summary Sheet, Technical Content, and Proposal Summary Budget.

Any applications received missing any of these required items will be returned without consideration.

3.03.01 Cover Sheet

Complete all items in "Cover Sheet" and use as page 1 of the proposal. **NO OTHER COVER WILL BE ACCEPTED.** Xerox copies are permitted.

No awards shall be made under this solicitation to small business concerns without TIN or DUNS numbers.

The TIN may be used by the Government to collect and report on any delinquent amounts arising out of the offeror's relationship with the Government (31 U.S.C. 7701(c)(3)). If the resulting contract is subject to the payment reporting requirements described in FAR 4.904, the TIN provided hereunder may be matched with IRS records to verify the accuracy of the offeror's TIN.

The DUNS number is a nine-digit number assigned by Dun and Bradstreet Information Services. If the offeror does not have a DUNS number, it should contact Dun and Bradstreet directly to obtain one. A DUNS number will be provided immediately by telephone at no charge to the offeror. For information on obtaining a DUNS number, the offeror, if located within the United States, should call Dun and Bradstreet at 1-800-333-0505. The offeror should be prepared to provide the following information:

(1) Company name.
(2) Company address.
(3) Company telephone number.
(4) Line of business.
(5) Chief executive officer/key manager.
(6) Date the company was started.
(7) Number of people employed by the company.
(8) Company affiliation.

Offerors located outside the United States may obtain the location and phone number of the local Dun and Bradstreet Information Services office from the Internet home page at http://www.customerservice@dnb.com. If an offeror is unable to locate a local service center, it may send an e-mail to Dun and Bradstreet at globalinfo@mail.dnb.com.

3.03.02 Project Summary

Complete Section 8.02 "Project Summary" as page 2 of your proposal. The technical abstract should include a brief description of the problem or opportunity, the innovation, project objectives, and technical approach.

In summarizing anticipated results, include technical implications of the approach and the potential commercial applications of the research. **The Project Summary of proposals that receive an award will be published by NIST and, therefore, must not contain proprietary information.**

3.03.03 Technical Content

Beginning on **page 3 of the proposal**, include the following items with headings as shown:

(a) **Identification and Significance of the Problem or Opportunity.** Make a clear statement of the specific research problem or opportunity addressed, its innovativeness, commercial potential, and why it is important. Show how it applies to a specific subtopic in Section 9.

(b) **Phase 1 Technical Objectives.** State the specific objectives of the Phase 1 effort, including the technical questions it will try to answer, to determine the feasibility of the proposed approach.

(c) **Phase 1 Work Plan.** Include a detailed description of the Phase 1 R&D plan. The plan should indicate what will be done, where it will be done, and how the R&D will be carried out. The methods planned to achieve each objective or task should be discussed in detail. This section should be at least one-third of the proposal. **NIST technical support or assistance may be available to awardees in the conduct of the research only if specifically provided for in the subtopic description.** NIST may not enter into, nor continue, a CRADA with an awardee on the subtopic of the award.

(d) **Related Research or R&D.** Describe research or R&D that is directly related to the proposal, including any conducted by the principal investigator or by the proposer's firm. Describe how it relates to the proposed effort, and describe any planned coordination with outside sources. The purpose of this section is to persuade reviewers of the proposer's awareness of recent developments in the specific topic area.

(e) **Key Personnel and Bibliography of Related Work.** Identify key personnel involved in Phase 1, including their related education, experience, and publications. Where resumes are extensive, summaries that focus on the most relevant experience and publications are suggested. List all other commitments that key personnel have during the proposed period of contract performance.

(f) **Relationship with Future R&D.** Discuss the significance of the Phase 1 effort in providing a foundation for the Phase 2 R&D effort. Also state the anticipated results of the proposed approach, if Phases 1 and 2 of the project are successful.

(g) **Facilities and Equipment.** The conduct of advanced research may require the use of sophisticated instrumentation or computer facilities. The proposer should provide a detailed description of the availability and location of the facilities and equipment necessary to carry out Phase 1. **NIST facilities and/or equipment may be available for use by awardees only if specifically provided for in the subtopic description.**

(h) **Consultants and Subcontracts.** The purpose of this section is to convince NIST that:

(1) research assistance from outside the firm materially benefits the proposed effort, and
(2) arrangements for such assistance are in place at the time the proposal is submitted.

Outside involvement in the project is encouraged where it strengthens the conduct of the research; such involvement is not a requirement of this solicitation.

1. Consultant - A person outside the firm, named in the proposal as contributing to the research, must provide a signed statement confirming his/her availability, role in the project, and agreed consulting rate for participation in the project. **This statement is part of the page count.**

2. Subcontract - Similarly, where a subcontract is involved in the research, the subcontracting institution must furnish a letter signed by an appropriate official describing the programmatic arrangements and confirming its agreed participation in the research, with its proposed budget for this participation. **This letter is part of the page count.**

No individual or entity may serve as a consultant or subcontractor if they:
Had any role in suggesting, developing, or reviewing the subtopic; or
Have been the recipient of any information on the subtopic not available to the public.

(i) **Potential Commercial Application and Follow-on Funding Commitment.** Describe in detail the commercial potential of the proposed research, how commercialization would be pursued and potential use by the Federal Government.

(j) **Cooperative Research and Development Agreements (CRADA).** State if the applicant is a former or current CRADA partner with NIST, or with any other Federal agency, naming the agency, title of the CRADA, and any relationship with the proposed work. An Agency may not enter into, nor continue, a CRADA with an awardee on the subtopic of the award.

(k) **Guest Researcher.** State if the applicant is a guest researcher at NIST, naming the sponsoring laboratory.

(l) **Cost Sharing.** Cost participation could serve the mutual interest of NIST and certain SBIR contractors by helping to assure the efficient use of available resources. Except where required by other statutes, NIST does not encourage or require cost sharing on Phase 1 projects, nor will cost sharing be a consideration in evaluation of Phase 1 proposals.

3.03.03.01 Similar Proposals or Awards

WARNING - While it is permissible with proposal notification to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous Federal program solicitations, it is unlawful to enter into funding agreements requiring essentially equivalent work. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies before award. If an applicant elects to submit identical proposals or proposals containing a significant amount of essentially equivalent work under other Federal program solicitations, a statement must be included in each such proposal indicating:

(i) The name and address of the agencies to which proposals were submitted or from which awards were received.
(ii) Date of proposal submission or date of award.
(iii) Title, number, and date of solicitations under which proposals were submitted or awards received.
(iv) The specific applicable research topics for each proposal submitted or award

received.
(v) Titles of research projects.
(vi) Name and title of principal investigator or project manager for each proposal submitted or award received.

If no equivalent proposal is under consideration or equivalent award received, a statement to that effect **must** be included in this section.

3.03.03.02 Prior SBIR Phase 2 Awards

If the small business concern has received more than 15 Phase II awards in the prior 5 fiscal years, it must submit in its Phase I proposal: name of the awarding agency; date of award; funding agreement number; amount of award; topic or subtopic title; follow-on agreement amount; source and date of commitment ; and current commercialization status for each Phase II award. **This required information shall not be part of the page count limitation.**

NOTE: The Small Business Administration is mandated to establish an SBIR awardee database containing demographic, technical, outcome and output information on all SBIR awards. The database is still being developed as of the date of release of this solicitation. When it becomes available, all NIST SBIR awardees will be required to supply the required data in a timely fashion.

3.03.04 Proposed Budget

SBA Policy requires that NIST not issue SBIR awards that include provisions for subcontracting any portion of the contract back to the originating agency.

For Phase I, a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing small business concern. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing small business concern.

Complete the SBIR Proposal Summary Budget for the Phase 1 effort, and include it as the last page of the proposal. Some items of this form may not apply. Enough information should be provided to allow NIST to understand how the offeror plans to use the requested funds if the award is made. A complete cost breakdown should be provided giving labor rates, proposed number of hours, overhead, G&A, and profit. A reasonable profit will be allowed. When proposing travel, identify the number of trips, people involved, labor categories, destination of travel, duration of trip, commercial air fare or mileage rate, per diem expenses, and purpose of travel. Budgets for travel funds must be justified and related to the needs of the project.

Where equipment is to be purchased, list each individual item with the corresponding cost. The inclusion of equipment will be carefully reviewed relative to need and appropriateness for the research proposed. Equipment is defined as an article of non-expendable, tangible property having a useful life of more than 1 year and an acquisition cost of $5,000 or more per unit.

3.03.04.01 Budget Instructions

The offeror is to submit a cost estimate with detailed information for each element, consistent with the offeror's cost accounting system. This does not eliminate the need to fully document and justify the amounts requested in each category. Such documentation should be contained, as appropriate, on a budget explanation page immediately preceding the budget in the proposal.

1. Principal Investigator (PI).
The PI must be with the small business concern at the time of contract award and during the period of performance of the research effort. Additionally, more than half of the PI's time must be spent with the small business firm during the contract performance.

2.Direct Labor.
All personnel (including PI) must be listed individually, with the projected number of hours and hourly wage.

3. Overhead Rate.
Specify current rate and base. Use current rate already negotiated with a Federal agency, if available. If no rate has been negotiated, a reasonable overhead rate may be requested, which will be subject to approval by NIST.

4. Other Direct Costs.
List all other direct costs which are not described above (i.e. consultants, subcontractor, travel, and equipment purchases). Each of the above needs a detailed explanation and elaboration of its relation to the project.

5. Materials.
The materials and supplies required for the project must be identified. There is also a need to specify type, quantity, unit cost, and total estimated cost of these materials and supplies.

6. General & Administration (G&A).
Specify current rate and base. Use current rate already negotiated with a Federal agency, if available. If no rate has been negotiated, a reasonable G&A rate may be requested, which will be subject to approval by NIST.

7. Profit.
The small business may request a reasonable profit (about 7 percent of costs is the average proposed).

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.01 Introduction

All Phase I and II proposals will be evaluated and judged on a competitive basis. Proposals will be initially screened to determine responsiveness. Proposals passing this initial screening will be technically evaluated by engineers or scientists to determine the most promising technical and scientific approaches. Each proposal will be judged on its own merit. The Agency is under no obligation to fund any proposal or any specific number of proposals in a given topic. It also may elect to fund several or none of the proposed approaches to the same topic or subtopic

4.02 Phase 1 Screening Criteria

To avoid misunderstanding, small businesses are cautioned that Phase 1 proposals not satisfying all the screening criteria shall be returned without peer review and will be eliminated from consideration for funding. Proposals may not be resubmitted (with or without revision) under this solicitation. All copies of proposals that fail the screening process will be returned. The screening criteria are:

(a) The proposing firm must qualify as eligible according to the criteria set forth in Section 1.3.

(b) The Phase 1 proposal must meet **all** of the requirements stated in Section 3.

(c) The Phase 1 proposal must be limited to one subtopic and clearly address research for that subtopic.

(d) **Phase 1 proposal budgets must not exceed $75,000,** including subcontract, indirect cost, and fee.

(e) **The project duration for the Phase 1 research must not exceed 6 months.**

(f) The proposal must contain information sufficient to be peer reviewed as research.

4.03 Phase 1 Evaluation Criteria

Phase 1 proposals that comply with the screening criteria will be rated by NIST scientists or engineers in accordance with the following criteria:

(a) The scientific and technical merit of the proposed research (25 points)

(b) Innovation, originality, and feasibility incumbent of the proposed research (25 points)

(c) Relevance and responsiveness of the proposed research to the subtopic to which it is addressed (25 points)

(d) Quality and/or adequacy of facilities, equipment, personnel described in the proposal (15 points)

(e) Quality of the proposal with respect to potential commercialization and/or Federal Procurements of the products and/or services sought by the subtopic (10 points)

Technical reviewers will base their ratings on information contained in the proposal. It cannot be assumed that reviewers are acquainted with any experiments referred to, key individuals, or the firm.

Final award decisions will be made by NIST based upon ratings assigned by reviewers and consideration of additional factors, including possible duplication of other research, the importance of the proposed research as it relates to NIST needs, and the availability of funding. NIST may elect to fund several or none of the proposals received on a given subtopic. Upon selection of a proposal for a Phase 1 award, NIST reserves the right to negotiate the amount of the award.

4.04 Phase 2 Evaluation Criteria

The Phase 2 proposal will undergo NIST and/or external peer review in accordance with the following criteria:

1. Degree to which Phase I objectives were met (25 points)
2. The scientific and technical merit of the proposed research, including innovation, originality, and feasibility (25 points)
3. Quality and/or adequacy of facilities, equipment, personnel described in the proposal (25 points)
4. Quality of the proposer and the proposal with respect to potential commercialization and/or Federal Procurements of the products and/or services sought by the subtopic. This involves some or all of the following factors, as appropriate; how well the proposal meets NIST mission/OU program needs; proposer's record of successful commercialization and/or Federal Procurement of research in the past; existence of non-SBIR Phase II funding commitments, existence of Phase III funding or partnering commitments (25 points)

4.05 Release of Proposal Review Information

After final award decisions have been announced, the technical evaluations of a proposal will be provided to the proposer with their written notification of award/non-award. The identity of the reviewers will not be disclosed.

5.0 CONSIDERATIONS

5.01 Awards

NIST awards firm-fixed-price contracts as the type of funding agreement to successful offerors. A firm-fixed-price contract provides for a price that is not subject to any adjustment on the basis of the contractor's cost experience in performing the contract. This contract type places upon the contractor the risk and full responsibility for all costs and resulting profit or loss. It provides maximum incentive for the contractor to control costs and perform effectively and imposes a minimum administrative burden upon both contracting parties. NIST also does not allow any advance payments to be made on its contract awards.

Contingent upon availability of funds, NIST anticipates making about 32 Phase 1 firm-fixed-price awards of no more than $75,000 each. Performance period shall be no more than 6 months beginning on the contract start date.

Phase 2 awards shall be for no more than **$300,000**. The period of performance in Phase 2 will depend upon the scope of the research, but should not exceed 24 months.

It is anticipated that **approximately one-third of the Phase 1 awardees will receive Phase 2 awards,** depending upon the availability of funds. To provide for an in-depth review of the Phase 1 final report and the Phase 2 proposal and commercialization plan, Phase 2 awards will be made approximately 4 months after the completion of Phase 1, contingent upon availability of funds.

This solicitation does not obligate NIST to make any awards under either Phase 1 or Phase 2. Furthermore, NIST is not responsible for any monies expended by the proposer before any award is made resulting from this solicitation.

Upon award of a funding agreement, the awardee will be required to make certain legal commitments through acceptance of numerous clauses in Phase I funding agreements. The outline that follows is illustrative of the types of clauses to which the contractor would be committed. This list is not a complete list of clauses to be included in Phase I funding agreements, and is not the specific wording of such clauses. Copies of complete terms and conditions are available upon request.

These statements are examples only and may vary depending upon the type of funding agreement used.

(1) Standards of Work. Work performed under the funding agreement must conform to high professional standards.
(2) Inspection. Work performed under the funding agreement is subject to Government inspection and evaluation at all times.
(3) Examination of Records. The Comptroller General (or a duly authorized representative) must have the right to examine any pertinent records of the awardee involving transactions related to this funding agreement.
(4) Default. The Government may terminate the funding agreement if the contractor fails to perform the work contracted.
(5) Termination for Convenience. The funding agreement may be terminated at any time by the Government if it deems termination to be in its best interest, in which case the awardee will be compensated for work performed and for reasonable termination costs.
(6) Disputes. Any dispute concerning the funding agreement that cannot be resolved by agreement must be decided by the contracting officer with right of appeal.
(7) Contract Work Hours. The awardee may not require an employee to work more than 8 hours a day or 40 hours a week unless the employee is compensated accordingly (for example, overtime pay).
(8) Equal Opportunity. The awardee will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.
(9) Affirmative Action for Veterans. The awardee will not discriminate against any employee or application for employment because he or she is a disabled veteran

or veteran of the Vietnam era.
(10) Affirmative Action for Handicapped. The awardee will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.
(11) Officials Not To Benefit. No Government official must benefit personally from the SBIR funding agreement.
(12) Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the funding agreement upon an understanding for compensation except bonafide employees or commercial agencies maintained by the awardee for the purpose of securing business.
(13) Gratuities. The funding agreement may be terminated by the Government if any gratuities have been offered to any representative of the Government to secure the award.
(14) Patent Infringement. The awardee must report each notice or claim of patent infringement based on the performance of the funding agreement.
(15) American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.02 Reports

Three copies of a final report on the Phase 1 project shall be submitted to NIST within 30 calendar days after completion of the Phase 1 research. The final report shall include a single-page project summary as the first page, identifying the purpose of the research, and giving a brief description of the research carried out, the research findings or results, and the commercial applications of the research in a final paragraph. The remainder of the report should indicate in detail the research objectives, research work carried out, results obtained, and estimates of technical feasibility.

All final reports must carry an acknowledgment on the cover page such as: "This material is based upon work supported by the National Institute of Standards and Technology (NIST) under contract, grant, or cooperative number___________. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of NIST."

5.03 Payment Schedule

The specific payment schedule (including payment amounts) for each award will be incorporated into the funding agreement.

No advance payments will be allowed.

NIST will allow the Phase 1 award amount to be paid on a bimonthly interim basis upon delivery and acceptance of three progress reports that describe services performed, and one final payment upon delivery and acceptance of the final report. Likewise, NIST will allow the Phase 2 award amount to be paid on a semi-annually interim basis upon delivery and acceptance of four progress reports that describe services performed, and one final payment upon delivery of the final report.

5.04 Proprietary Information, Inventions, and Patents

5.04.01 Limited Rights Information and Data

Information contained in unsuccessful proposals will remain the property of the proposer. Any proposal which is funded will not be made available to the public, except for the "Project Summary" page.

The inclusion of proprietary information is discouraged unless it is necessary for the proper evaluation of the proposal.

Information contained in unsuccessful proposals will remain the property of the applicant. The Government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements. If proprietary information is provided by an applicant in a proposal, which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law. This information must be clearly marked by the applicant with the term "confidential proprietary information" and the following legend must appear on the title page of the proposal:

> "These data shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part for any purpose other than evaluation of this proposal. If a funding agreement is awarded to this applicant as a result of or in connection with the submission of these data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement and pursuant to applicable law. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction are contained on pages ____ of this proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the proposal from further consideration, without assuming any liability for inadvertent disclosure. The Government will limit dissemination of such information to within official channels."

5.04.02 Copyrights

The contractor may normally establish claim to copyright any written material first produced in the performance of an SBIR contract. If a claim to copyright is made, the contractor shall affix the applicable copyright notice of 17 U.S.C. 401 or 402 and acknowledgment of Government sponsorship (including funding agreement number) to the material when delivered to the Government, as well as when the written material or data are published or deposited for registration as a published work in the US Copyright Office. For other than computer software, the contractor gives to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable, worldwide license to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government.

For computer software, the contractor gives to the Government a paid-up, nonexclusive, irrevocable, worldwide license for all such computer software to reproduce, prepare derivative works, and perform publicly and display publicly, by or on behalf of the Government.

5.04.03 Data Rights

Except for copyrighted data, the Government shall normally have unlimited rights in:

(a) data specifically identified in the SBIR funding agreement to be delivered without restriction;

(b) form, fit, and function data delivered under the funding agreement;

(c) data delivered under the funding agreement that constitute manuals or instructions and training material for installation, operation, or routine maintenance and repair of items, components, or processes delivered or furnished for use under the funding agreement; and

(d) all other data delivered under the funding agreement unless identified as SBIR data.

According to Federal Acquisition Regulation 52.227-20, Rights and Data - SBIR Program (March 1994), the awardee is authorized to affix the following "SBIR Rights Notice" to SBIR data delivered under the funding agreement:

SBIR RIGHTS NOTICE

These SBIR data are furnished with SBIR rights under Contract No.____________ (and subagreement _________________, if appropriate). For a period of 4 years after acceptance of all items to be delivered under this award, the Government agrees to use these data for Government purposes only, and they shall not be disclosed outside the Government (including disclosure for procurement purposes) during such period without permission of the awardee, except that, subject to the forgoing use and disclosure prohibitions, such data may be disclosed for use by support contractors.. After the aforesaid 4-year period, the Government has a royalty-free license to use, and to authorize others to use on its behalf, these data for Government purposes, but is relieved of all disclosure prohibitions and assumes no liability for unauthorized use of these data by third parties. This Notice shall be affixed to any reproductions of these data, in whole or in part.

(END OF NOTICE)

The Government's sole obligation with respect to any properly identified SBIR data shall be as set forth in the paragraph above.

5.04.04 Patents

Small business concerns normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royaltyfree license for Federal Government use, reserves the right to require the patent holder to license others in certain circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35U.S.C. 205, the Government will not make public any information disclosing a Governmentsupported invention for a minimum 4-year period (that may be extended by subsequent SBIR funding agreements) to allow the awardee a reasonable time to pursue a patent.

5.04.05 Invention Reporting

SBIR awardees must report inventions to the awarding agency within 2 months of the inventor's report to the awardee. The reporting of inventions may be accomplished by submitting paper documentation, including fax.

5.05 Additional Information

(1) This program solicitation is intended for informational purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR funding agreement, the terms of the funding agreement are controlling.

(2) Before award of an SBIR funding agreement, the Government may request the applicant to submit certain organizational, management, personnel, and financial information to assure responsibility of the applicant.

(3) The Government is not responsible for any monies expended by the applicant before award of any funding agreement.

(4) This program solicitation is not an offer by the Government and does not obligate the Government to make any specific number of awards. Also, awards under the SBIR Program are contingent upon the availability of funds.

(5) The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals must not be accepted under the SBIR Program in either Phase I or Phase II.

(6) If an award is made pursuant to a proposal submitted under this SBIR Program solicitation, a representative of the contractor will be required to certify that the concern has not previously been, nor is currently being, paid for essentially equivalent work by any Federal agency.

(7) The responsibility for the performance of the principal investigator, and other employees or consultants who carry out the proposed work, lies with the management of the organization receiving an award.

(8) Cost-sharing is permitted for proposals under this program solicitation; however, cost-sharing is not required. Cost-sharing will not be an evaluation factor in consideration of your Phase I proposal.

5.06 Research Projects with Human Subjects, Human Tissue, Data or Recordings Involving Human Subjects

Any proposal that includes research involving human subjects, human tissue, data or recordings involving human subjects must meet the requirements of the Common Rule for the Protection of Human Subjects, codified for the Department of Commerce at 15 CFR Part 27. In addition, any proposal that includes such research on these topics must be in compliance with any statutory requirements imposed upon NIH and other federal agencies regarding these topics, all regulatory policies and guidance adopted by NIH, FDA, and other federal agencies on these topics, and all Presidential statements of policy on these topics. Any questions regarding these requirements should be addressed to Melissa Lieberman at (301) 975-4783 or melissa.lieberman@nist.gov.

IRB Education Documentation. A signed and dated letter is required from the Organizational Official who is authorized to enter into commitments on behalf of the organization documenting that appropriate IRB education has been received by the Organizational Official, the IRB Coordinator or such person that coordinates the IRB documents and materials if such a person exists, the IRB Chairperson, all IRB members and all key personnel associated with the proposal. The NIST requirement of documentation of education is consistent with NIH notice OD-00-039 (June 5, 2000). Although NIST will not endorse an educational curriculum, there are several curricula that are available to organizations and investigators which may be found at: http://grants.nih.gov/grants/guide/notice-files/NOT-OD-00-039.html.

5.07 Research Projects Involving Vertebrate Animals

Any proposal that includes research involving vertebrate animals (including fish) must be in compliance with the National Research Council's "Guide for the Care and Use of Laboratory Animals" which can be obtained from National Academy Press, 2101 Constitution Avenue, NW, Washington, D.C. 20055. In addition, such proposals must meet the requirements of the Animal Welfare Act (7 U.S.C. 2131 et seq.), 9 CFR Parts 1, 2, and 3, and if appropriate, 21 CFR Part 58. These regulations do not apply to proposed research using pre-existing images of animals or to research plans that **do not** include live animals that are being cared for, euthanased, or used by the project participants to accomplish research goals, teaching, or testing. These regulations also do not apply to obtaining animal materials from commercial processors of animal products or to animal cell lines or tissues from tissue banks.

6.0 SUBMISSION OF PROPOSALS

6.01 Deadline for Proposals

Deadline for Phase 1 proposal receipt (4 copies) at the address below is **3:00 pm** on **January 15, 2003 at the Contracts Office address below.**

All Offerors should expect delay in delivery due to added security at NIST. It is the responsibility of the Offeror to make sure delivery is made on time.

Because of the heightened security at NIST, FED-EX, UPS or similar-type service is the preferred method of delivery of proposals.

If proposals are to be hand delivered, delivery must be made on the actual deadline date and a 24-hour notice must be made to the NIST Contracts Office prior to delivery. All Offerors must notify Susan Brinkman at 301-975-8007, or Sandra Febach at 301-975-6326. The name of the individual or courier company making the delivery must be included in the notification.

NIST assumes no responsibility for evaluating proposals received after the stated deadline or that do not adhere to the other requirements of this solicitation (see checklist at back of booklet). Such proposals **will** be returned to the proposer without review.

Federal Acquisition Regulation (FAR 52 215-1) regarding late proposals shall apply.

Letters of instruction will be sent to those eligible to submit Phase 2 proposals. The Phase 2 proposals are due at about the same time as Phase 1 final reports - 7 months after commencement of the Phase 1 contract.

Proposers are cautioned to be careful of unforeseen delays, which can cause late arrival of proposals at NIST, resulting in them not being included in the evaluation procedures. No information on the status of proposals under scientific/technical evaluation will be available until formal notification is made.

6.02 Proposal Submission

Submission of Proposal Packages as defined in section 3.3 should be sent in **4 copies** to:

National Institute of Standards and Technology
Acquisitions and Logistics Division
Attn: Susan Brinkman
100 Bureau Drive STOP 3571
Building 301, Room B129
Gaithersburg, MD 20899-3571

Phone Number: (301) 975-8007

Photocopies will be accepted. All signatures in each of the four copies MUST be ORIGINAL, i.e no photocopies of signatures will be accepted.

Acknowledgment of receipt of a proposal by NIST will be made. All correspondence relating to proposals must cite the specific **proposal number** identified on the acknowledgment.

(a) **Packaging--Secure packaging is mandatory. NIST cannot process proposals damaged in transit. All 4 copies of the proposal must be sent in the same package. Do not send separate "information copies," or several packages containing parts of a single proposal, or two packages of 4 copies of the same proposal**

(b) Bindings--**Do not use special bindings or covers.** Staple the pages in the upper left hand corner of each proposal. Separation or loss of proposal pages cannot be the responsibility of NIST.

6.03 Warning

While it is permissible, with proper notification to NIST, to submit identical or essentially equivalent proposals for consideration under numerous Federal program solicitations, it is unlawful to enter into funding agreements requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies before award.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION SOURCES

Background information related to the NIST research programs referenced within the subtopics may be found within the NIST website at: www.nist.gov. Wherever possible, reference citations are provided within the individual subtopics.

8.0 SUBMISSION FORMS AND CERTIFICATIONS

8.01 Cover Sheet (2 pages)

8.02 Project Summary

8.03 Proposed Budget

8.04 - Checklist of Requirements

Please review this checklist carefully to assure that your proposal meets the NIST requirements. All signatures in the above forms MUST be original. **No photocopies of signatures will be accepted.** Failure to meet these requirements will result in your proposal being returned without consideration. **Four copies of the proposal must be received by 3:00p.m. EST January 15, 2003.**

1. The **COVER SHEET** (both pages combined) has been completed and is **PAGE 1** of the proposal.
2. The **PROJECT SUMMARY** has been completed and is **PAGE 2** of the proposal.
3. The **TECHNICAL CONTENT** of the proposal **begins on PAGE 3** and includes the items identified in **SECTION 3.3.3** of the solicitation. The technical content section of the proposal is limited to 22 pages in length.

4. The **SBIR PROPOSAL SUMMARY BUDGET** has been completed and is the **LAST PAGE** of the proposal.
5. The proposal is **25 PAGES OR LESS** in length.
6. The proposal is limited to only **ONE** of the subtopics in Section 9.
7. The proposal budget is for **$75,000 or LESS**. No more than one-third of the budget goes to consultants and/or subcontractors.
8. The abstract contains **no proprietary information** and does **not exceed** space provided on the Project Summary.
9. The proposal contains only pages of 21.6cm X 27.9cm size (8 ½" X 11").
10. The proposal contains **an easy-to-read font (fixed pitch of 12 or fewer characters per inch or proportional font of point size 10 or larger) with no more than 6 lines per inch,** except as a legend on reduced drawings, but not tables.
11. The P.I. is employed by the company.

NOTE: Proposers are cautioned to be careful of unforeseen delays that can cause late arrival of proposals, with the result that they **WILL** be returned without evaluation.

9.0 TOPIC AREAS

9.01 ADVANCED BIOLOGICAL AND CHEMICAL SENSING TECHNOLOGIES

9.01.01 Subtopic: New Molecular Primary Ion Beam Source For Cluster Secondary Ion Mass Spectrometry

Analysis of organic and biomolecular surfaces by Cluster Secondary Ion Mass Spectrometry (SIMS) is a key emerging technology for health care and homeland security. NIST is currently using this technology in projects ranging from mapping of cancer chemotherapeutic agents in tumor cells to analysis of high explosive particles for airport screening applications. To facilitate this work, NIST is using small cluster primary ion beam ion sources to interrogate organic and biological samples with a focused beam of SF5+ or C8- ions. These energetic polyatomic projectiles produce large enhancements in characteristic secondary ion signals allowing in-situ "molecular mapping" of the distribution of analyte molecules with micrometer spatial resolution. Unfortunately, commercial ion sources are not yet available which produce larger cluster ions with high primary ion beam currents and sufficient lifetimes to be practical for routine surface analysis.

In order to allow for continued advancement of this promising technology, NIST has a critical need for a new, large molecule cluster primary ion beam source. Computer modeling of ion-surface interactions suggests that a C60+ primary ion source would be optimal for molecular surface analysis. This type of ion source would have significant commercial potential, as it would permit analysis of molecular surfaces that are intractable with conventional ion beam analysis techniques.

During Phase 1 a C60+ primary ion beam source shall be designed and a working prototype constructed to demonstrate proof-of-concept and to characterize the operational parameters of the source. The prototype shall be delivered to NIST.

Should a phase 2 be awarded, a workable ion source that would be capable of directly interfacing to the NIST magnetic sector and time of flight SIMS instruments would be deliverable. Ion optical modeling of the primary ion beam column of the SIMS instruments would be required to design an appropriate coupling lens between the source and the instruments. The company would need limited access to NIST equipment in order to construct an ion optical model of the primary ion beam column.

9.02 ANALYTICAL METHODS

9.02.01 Subtopic: Low-Energy Ion Gun For Polyolefin Mass Spectrometry

The Polymers Division of the National Institute of Standards and Technology requires a low-energy (10 eV to 50 eV) ion gun that can direct a focused ion beam (approximately 5 mm x 5 mm in area) consisting of mass-selected low mass ions (1 u to 300 u) onto a polyolefin target in an existing vacuum system at a flux no lower than 1015 ions/cm2 s. The objective is to attach the incident ions to the polymer target by low-energy ion impact, and subsequently perform laser-desorption ionization of the charged polymer followed by time-of-flight mass separation of polymer molecules with the existing equipment. If achieved this objective would open a new method to perform polymer mass spectrometry on intact oligomers in a more controlled fashion that is the current state of the art.

The description of a suitable, but not necessarily optimal device, based on quadrupole ion separation can be found in: M.J. Hayward, F.D.S. Park, L.M. Manzella, S.L. Bernasek, "Sputtered protons during surface-induced dissociation (SID) tandem mass spectrometry (MS/MS)" International Journal of Mass spectrometry and Ion Processes 148 (1995) 25. A general review of similar devices based on a variety of concepts can be found in V. Grill, J. Shen, C. Evans, R.G. Cooks, "Collisions of ions with surfaces at chemically relevant energies: Instrumentation and phenomena" Review of Scientific Instruments 72 (2002) 3149.

Delivery of a prototype ion gun would be expected from a successful Phase 1 award to a reasonable extent. NIST will work collaboratively with awarde. The delivered device must be compatible with existing NIST equipment.

9.02.02 Subtopic: Software Development On High Speed Impact Of Multi-Layered Materials

Modern coating technologies such as CVD, PVD and laser-assisted ion sputtering techniques have enabled successful fabrication of multi-layered materials or devices at the nanometer size scale. These products have potential applications in computer and magnetic data storage industry such as hard disk drives. The tribological performance of the multi-layered devices is of major concern. In the case of hard disk drives, the consequence of sliding contact due to the collision of the slider at the head/disk interface during the high speed rotating service conditions needs to be ascertained.

Proposals are being solicited that will develop software packages to simulate the real time sliding contact event between nanoasperity and the smooth disk surface under high speed (in the order of 10 m/s of linear velocity) impact conditions. Both analytical and numerical approaches are encouraged. The input include: asperity size, impact velocity, properties of layered devices and geometry including layer thicknesses and, of course, contact pair characteristics (such as friction coefficient). For the given input, the software package will simulate the impact event and predicts the aftermath as a consequence of the severe impact. We are interested in finding the field solutions of stress, deformation and damage zone underneath the sliding plane, as well as time-history solutions of asperity penetration, energy transfer, heat generation, contact forces, deformation zone size and the solutions of contact duration and contact zone size. The work should be useful in assessing the service life of those devices for device designers and manufacturers.

Deliverable in phase 2 is expected to be source and executable software. Awardee(s) are encouraged to work collaboratively with NIST staff. Awardee(s) may need access to NIST facilities.

9.02.03 Subtopic: Ultra-High Resolution Capacitance Bridge

9.02.03 Subtopic: Ultra-High Resolution Capacitance Bridge

The Process Measurement Division and the Electricity Divisions of NIST are developing a standard of pressure in the range 0.3 MPa to 10 MPa based on measurements of the dielectric constants of gaseous helium and argon. As envisioned today, a user in a calibration laboratory would measure the temperature T and the dielectric constant e of pure argon gas and would determine the argon pressure p from the relationship:

P = Aargon (e - 1) [T/300K]{1 + (e -1) x (small correction s) + …}

NIST and other National Metrology Institutes will determine the best values of the coefficient Aargon and of the small correction terms. Approximately, Aargon = 200.74 MPa; thus, e -1 is approximately 0.00498 in argon at a pressure of 1 MPa. If this pressure standard is to reach its targeted uncertainty of 4 ppm (1 ppm = 1 part per million) when used with argon at 1 MPa, then e -1 must be determined with an uncertainty of 4 ppm. The determination of e -1 requires two measurements of capacitance that are separated by several hours to allow for thermal equilibration. The determination requires a capacitance bridge with specifications that exceed those of commercially manufactured bridges. The bridge must have a resolution 1x10-8, a differential linearity of better than 4x10-6, and a medium-term (six hours) stability of 2x10-8.

NIST has made substantial progress in developing capacitors that will be suitable for the pressure standard. [See: M. R. Moldover and T. J. Buckley, "Reference Values of the Dielectric Constant of Natural Gas Components Determined with a Cross Capacitor," Int. J. Thermophysics, Vol. 22, pp. 859-885 (2001).] Cross capacitors are advantageous in this application because they are nearly immune to surface contamination, for example, by layers of vacuum pump oil. Practical cross capacitors have very low capacitance. To date, NIST's Fluid Science Group has studied a 0.6 pF cross capacitor and a 1.7 pF cross capacitor. Both have been immersed in argon and other gases up to 7 MPa. Insofar as NIST can tell using a commercially manufactured capacitance bridge, both cross capacitors have suitable stability and deform under pressure as predicted. [The manufacturer of the bridge used for these tests claimed the specifications: (1) Accuracy: 3 ppm, (2) stability better than 0.5 ppm/year, (3) resolution of 0.5 attofarad and 0.07 ppm, and (4) temperature coefficient of 0.01 ppm/°C.] NIST is trying to manufacture a 5 pF cross capacitor.

Through this solicitation, NIST seeks a bridge with high resolution, high stability, and accurate differential linearity, as stated above. The bridge must achieve these specifications with capacitors in the range 0.5 pF to 10 pF. The bridge will be used to study NIST-supplied capacitors under vacuum and under argon pressures up to 10 MPa. As the argon pressure is applied, the maximum capacitance change will be about 5%, as implied by equation (1). The bridge should operate using at least two well-separated voltages, one of which could be as large as 100 VRMS.

Phase I shall include the delivery to NIST of a bridge that meets the specifications, is suitable for the intended application, and whose outputs are suitable for automated data acquisition systems. Should a Phase 2 be awarded, a capacitance bridge will be deliverable to NIST for testing by NIST personnel. To a reasonable extent, NIST will share its expertise with the company to accomplish these goals.

9.02.04 Subtopic: Ultra Low Energy Sputter Ion Beam System For Depth Profiling

Shrinking semiconductor device dimensions require increased depth resolution for compositional depth profiling analysis. Historically, the highest depth resolution has been achieved by using low energy primary ion bombardment which reduces the penetration depth of the primary ions into the analytical sample. However, the depth resolution required to analyze the next generation of thin gate oxides and ultra shallow dopants requires primary ion energies that are too low for most commercial surface analysis instruments. In addition, a rapid fall-off in erosion rate at lower bombardment energies makes low energy analysis impractical for most routine analyses. NIST is currently exploring another approach for high resolution, compositional depth profiling. This approach uses high energy (15 keV-25 keV) focused ion beam milling to rapidly remove material to produce a beveled cross-section of a semiconductor device. This cross-section can then be cleaned by removal of the 'mixed zone' produced during high-energy bombardment with subsequent ultra low energy ion milling. Because only a few tens of nanometers of material must be removed, the low erosion rates are not limiting, and the sputtering energy can be reduced to near-threshold levels. In principle, this approach should provide cross-sections with minimal perturbation of analyte distributions permitting higher depth resolution than is currently possible using conventional higher energy approaches. Subsequent analyses of the cross-sections by Auger Electron Spectroscopy, Secondary Ion Mass Spectrometry or Scanning Electron Microscopy can be used to define the composition and depth of the buried layers. The key component of this work is to develop a tabletop ion beam sputter system capable of ultra low energy bombardment with high bombardment uniformity. Successful development of such a system would have significant commercial potential because it would provide a method for extending the capabilities of surface analysis tools for characterizing the next generation of microelectronic devices.

The expected goal for Phase 1 is the demonstration of capability feasibility. Should a Phase 2 be awarded, a prototype low energy ion beam sputtering system shall be delivered to NIST. This would be tabletop system capable of bombarding an area of a few mm2 with an erosion rate of several nanometers/minute. The system is required to operate with primary ion beams of Ar+, Kr+, Xe+ as well as O2+. The erosion energy should be adjustable between 10 eV and 500 eV. Erosion should be uniform within a few percent over the bombarded area using either a rastered ion beam or by rotation of the sample. Proposals under this subtopic may address collaboration with NIST staff but not use of NIST facilities.

9.03 CONDITION-BASED MAINTENANCE

9.03.01 Subtopic: Ambient-Powered Wireless Network Smart Sensors For Machine Tools

In intelligent machine tools, ambient-powered wireless smart sensors play a key role. These sensors can be components in closed-loop systems or used for condition monitoring to improve product quality as well as production efficiency. However, for sensors to be widely used in machine tools, the sensor intelligence level must be increased and the price decreased. When integrated with micro-processing technology, the intelligence level of these sensors can be enhanced. Sensors powered by the ambient environment can be free of power cables and the need for battery changes. In addition, sensors with the capability of wireless communication with their host are unencumbered by cabling. This feature, in situations such as on a rotating spindle or grinding wheel, or in a hazardous environment, can ease the integration of sensors into systems and applications. NIST is conducting research and development work on a smart machine tool. We are currently working with IEEE and industry to standardize wireless communications interfaces for smart sensors and are seeking to establish a wireless framework for sensors. Hence, we solicit proposals for the development of ambient-powered network smart sensors with wireless communication protocols that can measure for example; machine vibration, temperature, hydraulic pressure, air and fluid flow... A multi-sensor smart device that can measure multiple physical phenomena will be given higher score in the proposal evaluation process. These sensors should be designed for machine tool applications and can be easily integrated with the IEEE 1451 family of standards. It is recommended that the proposing party be thoroughly familiar with the proposed IEEE P1451 family of standards. Copies of the standards and draft documents can be obtained from IEEE at 1-800-678-4333. Expected Phase I results are the delivery of some early or preliminarily functional ambient-powered, wireless, network smart prototypes with self-identification capability according to the IEEE 1451.x TEDS that can remotely send sensed data and TEDS data to a host. It is expected that a Phase II effort will result in the construction and demonstration of a full function prototype suitable for commercialization. Proposals submitted under this subtopic may address collaboration with NIST staff and/or access to NIST facilities.

9.03.02 Subtopic: Software Tools For IEEE 1451-Based Smart Sensor Networks

Digital communications networks promise to become ubiquitous. Applications of such network technology span the range from factories to offices, to homes, and to vehicles. Development of domain-oriented tools such as application specific, configuration, testing, deployment, and development tools has lagged behind the development of digital networks. Typically, buyers must commit to single-vendor solutions for many applications. This has limited innovation and concentrated market share in many industries. The recently approved IEEE 1451 Standard for a Smart Transducer Interface for Sensors and Actuators provides a new model for plug-and-play hardware and software. Applying this standard, users will be able to assemble 1451-compliant software and hardware modules from diverse suppliers into systems that work seamlessly in concert. Software tools, that enable the fast and efficient building of application solutions for 1451-based sensor networks and systems, are needed.

Innovative ideas may encompass methodologies, tools, applications software, and other such concepts, which reduce the time and effort needed to construct 1451-compliant applications. Expected Phase I results are the delivery of software design, architecture, or software code (including source code) using modern modeling tools, that enables the fast and efficient building of application for IEEE 1451-based wired or wireless sensor network. Expected Phase II results are the delivery of prototype software tools that is suitable for commercialization and a demonstration of the utility of the tools in a number of practical and commercial applications. Proposals submitted under this subtopic may address collaboration with NIST staff and/or access to NIST facilities.

9.04 HEALTHCARE AND MEDICAL PHYSICS

9.04.01 Subtopic: Accurate Dosimetry For Low-Energy Photon-Emitting Brachytherapy Sources

Dosimetry measurements on low-energy photon-emitting brachytherapy sources in tissue-equivalent media are very difficult to make accurately because of the very high dose-rate gradients in the vicinity of the sources. "Seed" sources used in prostate brachytherapy are calibrated at NIST in terms of air-kerma strength, having an uncertainty of about 1.5%. The NIST standard can be accurately transferred to therapy clinics through the use of well-ionization chambers, but multiplication by a dose rate constant to obtain dose-rate at a reference point in water (the clinical quantity of interest) introduces an additional 5% to 7% uncertainty due to limitations in currently achievable accuracy of dose-rate measurements. Conventional detectors in use today include small-volume ionization chambers, thermoluminescence dosimeters (TLDs), solid state devices (diodes and diamond detectors), plastic scintillators, and radiation-sensitive films. Current technology limits on detector size are on the order of 0.5 mm to 1 mm, usually in one dimension only. Thinner materials must be supported on thicker, often non-tissue-equivalent substrates. Sensitivity is usually attained only at the expense of added volume in the other two detector dimensions, compromising resolution in these dimensions. Requirements for new detectors include sizes of 0.5 mm or less in all three dimensions, the ability to operate under water, tissue equivalence in their radiation absorption and scattering properties for photons from 4 keV to 40 keV, and sensitivity sufficient to detect clearly an absorbed dose rate of 1 mGy/s, or, for passive devices, absorbed doses of 1 mGy. Proposals submitted under this subtopic may address access to NIST facilities and staff for providing calibrated sources for testing. Delivery to NIST of a working prototype device is expected.

Reference:

- R. Nath, L.L. Anderson, G. Luxton, K.A. Weaver, J.F. Williamson, and A.S. Meigooni, "Dosimetry of Interstitial Brachytherapy Sources: Recommendations of the AAPM Radiation Therapy Committee Task Group no. 43," Med. Phys. 22, 209-234 (1995).

9.04.02 Subtopic: Design And Fabrication Of Ultra-Small-Collecting-Area Extrapolation Ionization Chamber

Standardized dosimetry of small beta-particle sources used in intravascular brachytherapy require an extrapolation chamber with a 1-mm or less diameter collecting electrode. Construction of such an electrode with a 5 mm or less insulating ring between the collecting electrode and the guard area of the chamber is required for this subtopic. The existing NIST standard has the required 1 mm diameter, however the insulating ring is about 0.3 mm thick, rendering precise measurements difficult. To fit in the existing NIST extrapolation chamber, the collecting electrode must present a perfectly flat face, i.e. nothing must protrude above the electrode surface. This requires that the electrical connections between the collecting regions and the guard regions either come out the back of the electrode or along the surface of the electrode and down the side. The collecting electrode must be constructed with low atomic-number materials, as nearly water-equivalent as possible. The plane of the collecting electrode must exhibit a flatness to less than 10 mm over a 25 mm diameter. If, instead, an alternative design for an extrapolation chamber is developed, it should be of a design such as those given in the references, capable of having continuously variable air gaps of between 1 mm and 0.02 mm, with sufficient guard electrode area (at least 25 mm diameter), and with the high voltage and collecting electrodes parallel to better than 1 second of arc. Proposals submitted under this subtopic may address access to NIST facilities and staff for providing calibrated sources for testing. Delivery to NIST of a working prototype device is expected.

References:

- Soares, C.G., D. Halpern and C.-K. Wang, "Calibration and Characterization of Beta-Particle Sources for Intravascular Brachytherapy," Med. Phys. 25, 339-346 (1998).
- Bambynek,M., Entwicklung einer Multielectroden-Extrapolationskammer als Prototyp einer Primärnormal-Meßeinrichtung zur Darstellung und Weitergabe der Meßfröße Wasser-Energiedosis von Beta-Brachytherapiequellen, Thesis, University of Dortmund 2000.
- Soares, C.G., "Consistency standards for source strength of beta-particle sources," Vascular Radiotherapy Monitor 3, No. 3, 59-63 (2001).
- Bambynek, M. et. al, "Development of a multi-electrode extrapolation chamber as a prototype of a primary standard for the realization of the quantity of the absorbed dose to water for beta brachytherapy sources." Nucl. Inst. Meth., in press (2002)

9.04.03 Subtopic: Sensor Development For Thermal Treatment Of Cancer

Cancerous tumors can be treated using a number of techniques such as chemotherapy and radiation. More recently, the use of thermal treatment delivered using RF, Microwave or ultrasound, in combination with traditional treatment techniques is being explored. This is showing promise in terms increasing the rate and possibly the effectiveness of treatment and in the case of skin cancer, reducing scar tissue. Temperatures in the range of 45 to 51oC are sufficient to kill cancerous cells while leaving healthy tissue intact.

There is a general lack of standards in terms of identifying the optimum conditions (temperature, heat flux and time) for treatment as well as an inability to quantitatively measure / model the thermal distribution in tissue. Additionally, there are few measurements associated with the reliability of the technique in terms of destruction of cancerous tissue. This limits the widespread clinical adoption of the technique.

This proposal is looking for the application of suitable technology to assist in the development of standards for the thermal treatment of cancer. This should include the application of technology including micro sensors for real time measurement of the temperature field and also cell survivability. Additionally, the proposal needs to include an assessment as to the feasibility (in terms of reliability and efficacy) of using activated nano particles to enable local delivery of heat in the temperature regime outlined above.

Proposals submitted under this subtopic may address access to NIST staff and facilities for testing and characterization, Delivery to NIST of a working prototype device in phase 1 is expected.

9.05 HOMELAND SECURITY

9.05.01 Subtopic: Development Of 6Li-Loaded Plastic Scintillator

Sensitive neutron spectrometers are needed for detection of illicit shipments of nuclear materials and dispersed plutonium in the rubble and fallout from a "dirty bomb." The best current technology employs liquid scintillators, but problems with sealing and thermal expansion are disadvantages in producing rugged systems suitable for remote operation outdoors and for portable instruments to be handled in extreme field conditions. Plastic scintillators would not require absolute seals and would have much reduced thermal expansion problems. The goals of this project are to produce a 6Li-loaded plastic scintillator material with (A) comparable or higher light yield (relative to best liquid scintillators), (B) high transparency, (C) high lithium content, and (D) reasonable price, in sizes up to one meter square by 30 cm thick. It is expected that phase 1 will demonstrate significant progress toward the phase 2 goal of producing material meeting the requirments of (A), (B), (C), and (D) above.

9.05.02 Subtopic: Development Of A Micro-Machined Quadrupole Mass Spectrometer Array For Potential Use In Combination With IMS In "Field" Detection Of Explosives And Chemical Weapons Agents

Ion Mobility Spectrometry (IMS) is a staple method for detection of explosives and chemical weapons agents. In-field IMS instruments would greatly benefit from the addition of a low power, efficient, quadrupole mass spectrometer (QMS) to the detection system (e.g. Eiceman and Karpas, 1994, p106). Given current methods of micro-machining it is likely that a QMS could be developed as an array of electrodes on a single Si substrate (e.g. by extension of Paul, 1958, Fig. 19) (from hereon referred to as a mAQMS).

Phase One of this project shall consist of numerical and analytical modeling of the device and its performance as well as investigations into the feasibility of manufacture. Performance metrics such as transmission efficiency and mass resolution shall be explored theoretically. Power consumption and vacuum system requirements shall be analytically estimated. The feasibility of manufacture shall be determined by research into the literature and consultation with experts in the field. A report on all aspects of the Phase One research shall be provided to NIST at the end of Phase One. Although it may not be necessary, there could be collaboration between NIST and the company.

Phase Two shall consist of construction and testing of a prototype mass spectrometer. A working prototype mAQMS along with documentation and software shall be delivered to NIST at the end of Phase Two. The mAQMS shall be delivered in a small vacuum system equipped with a simple electron impact ion source that can be used for testing. A final ` on the operation and tests performed by the contractor shall be delivered at the completion of Phase Two.

References:

- Eiceman and Karpas, <u>Ion Mobility Spectrometry,</u> CRC Press, 1994.
- W. Paul et al., Zeitschrift fur Physick, Bd. 152, S. 143-182, 1958

9.05.03 Subtopic: Development Of Field Detectors For Radiological Measurements

Recent events involving terrorist activities both within the United States and abroad have focused attention on the level of our preparedness to deal with large-scale radiological, chemical, and biological threats. These events make it clear that issues involving radiation and radioactive materials must be addressed in proper emergency response plans prepared to address terrorist threats. The full spectrum of radiological threats from terrorists span the deliberate dispersal of radioactive material to the detonation of a nuclear weapon. While the most likely threat is the dispersal of radioactive materials, the use of a crude nuclear weapon against a major city cannot be dismissed. Early detection of terrorist activities involving radioactive materials as well as radiation safety guidance for emergency planners and emergency responders, including those responsible for restoring the disaster area, are also a primary issue to prevent and detect future attacks. The early detection of terrorist activities involves the capability of measuring trace level amounts of radioactive materials found in places where these materials are handled or transported. In the assembly of nuclear weapons the detection of uranium and plutonium is mandatory. For preventing the dispersal of radioactive materials, which is the threat posed by "dirty bombs," the requirements for monitoring the handling of radioactive sources is a more difficult task. Due to the variety of radioactive source use in industrial and medical applications all around the world. Cobalt-60, Cesium-137, Thulium-170, Iridium-192, Iodine-125, Technetium-99, Americium-241, and Radium-226 are some of a long list of radioactive materials used in many everyday applications. Efforts are needed in the development of new field detectors. In particular for handheld detectors for first responders and large are detectors for detection of radioactive source in moving vehicles.

Proposals submitted under this subtopic may address access to NIST facilities and staff, and delivery to NIST of a working prototype device is expected.

9.05.04 Subtopic: Development Of New MEMS-Based Heat-Flux Sensors

Proposals are solicited for the design and development of novel and inexpensive MEMS-based heat-flux sensors for the measurement of flux levels to 50 kW/m2 or higher for fire and aerospace tests and for installation in buildings, airplanes, and other critical infrastructure. Present Gardon and Schmidt-Boelter sensors are expensive and need to be individually calibrated, making them impractical for many applications. Such applications include routine installation in buildings and airplanes to help provide advance information on fire propagation, prevent structural damage, and determine the cause of structural collapse. The proposed sensor must measure both radiative and convective heat flux. Phase II will require delivery of ten sensors to NIST for evaluation, each configured to provide a voltage output related to the heat-flux level. Ideally, some of these sensors would come from the same manufacturing batch to assess whether calibrating one such sensor from the lot is sufficient. Proposals for inexpensive heat-flux sensors based on other technologies will also be considered.

9.05.05 Subtopic: Digital Spur Detection And Suppression

Interference generated by other radio systems, and noise caused by acoustic and structure-borne vibrations, can seriously degrade the performance of communications systems. This is particularly true for modern narrowband systems, which employ a spectrally pure signal that carries the information as a modulation. Communications disruptions can be especially severe where a large number of such systems are brought into operation in close proximity to one another, a situation that often occurs during responses to major disasters. In such situations, vibration sources and other radios induce bright spectral lines, often called spurs, on the reference carrier of the affected system.

Traditional methods for dealing with such problems have focused on wideband noise detection and suppression using high-Q cavities and other related methods. But close-to-carrier discrete lines are often found in state-of-the-art oscillators, and traditional suppression schemes cannot effectively remove many of them. However, the spurs can be readily detected and measured by decomposing the noise voltage in the frequency domain using wideband approaches with, for example, a common vector spectrum analyzer. One can correct for these low-frequency spurs (in the audio range) by subtracting a digitally generated version of the spurs based on their detection. This approach is used in the audio spectrum for selective noise-cancellation, auditorium feedback suppression, and room acoustic and vibration isolation, and even enhancement of noisy music and speech transmissions. Successful suppression of spurs would have significant impact on virtually all applications requiring oscillators or clocks, many of which must be able to operate in environments where spurs well-above random noise are generated by interfering systems and by acoustic and structure-born vibration. Aside from communications applications, such oscillators are needed by NIST as references for noise measurement systems.

The phase 1 portion of this opportunity calls for an investigation of methods of using digital detection and subsequent subtraction of oscillator spurs that are above the random noise level. If one or more methods are envisioned as promising, continuation to phase 2 will be warranted, and this will call for development and delivery of a prototype oscillator system for demonstration of concepts. Proposals submitted under this subtopic may address access to NIST facilities for testing and characterization.

9.05.06 Subtopic: High-Q Cavities For Biological And Chemical Warfare Agent Identification

Proposals are solicited for novel high-Q microwave, millimeter wave, or submillimeter wave cavities for the measurements of the real and imaginary parts of the index-of-refraction of chemical and biological aerosols for chemical and biological warfare agent identification. Present biological and chemical aerosol sensors can detect aerosol particles, but are unable to reliably identify the agent. One might use the cavity resonance shift upon aerosol loading to determine the real part of the index of refraction. The resonance linewidth change will be used to infer the imaginary part of the index of refraction, i.e., the absorption coefficient. To perform the measurements, the cavity must be able to contain one atmosphere pressure of flowing aerosolized air. The microwave cavity method will require another technique to infer the aerosol concentration and particle size and a database of agent properties to allow identification, neither of which are part of the present solicitation. Phase II will require the delivery of a microwave, millimeter wave, or submillimeter wave cavity for NIST evaluation.

9.05.07 Subtopic: Measurement System To Detect Shielded Radioactivity Sources

In the war against terrorist threats from use of nuclear weapons of mass destruction and radiological dispersal devices ("dirty bombs"), detection of the weapon before its release is of prime importance. To date, radiation-detection instrumentation has been developed to detect unshielded radioactive materials. It is likely, however, that terrorists would realize that shielding the weapons would greatly reduce their being detected. It is the objective of this SBIR solicitation to have a new generation of radiation-sensing devices developed which would be able to detect shielded sources of gamma, beta, and alpha emitting radionuclides. The sensitivity of such measurement systems should be able to detect a 3.7e10 Bq Cs-137 and Sr-90 sources, and a 2.3e12 Bq Pu-239 source in a 5-cm thick Pb shield at 25 meters.

9.05.08 Subtopic: MRI, CT, And CAD Input Conversion Software For Virtual MCNP (Monte Carlo) Gamma-Ray Calibrations And Measurements

The U.S. faces a serious potential terrorist threat from use of nuclear weapons of mass destruction and radiological dispersal devices ("dirty bombs"). Gamma-ray spectroscopy is very effective in detecting and quantifying high-energy sources of radiation that would emanate from the weapon. However, it is imperative that the instrument be calibrated accurately to quantify the strength of the radiation source. Since the weapons could come in a large variety of shapes and compositions, a flexible means of calibrating the instrument must be available. MCNP is a very powerful Monte Carlo code that allows the analyst to compute a virtual calibration for the gamma-ray spectrometer when crucial parameters about the weapon can be described to the code. Presently, the MCNP code is not configured for user-friendly and simple input description of any complicated object. It is the objective of this SBIR solicitation to develop user-friendly input-conversion software that will quickly and simply convert MRI, CT, and CAD files into MCNP input files, including detector-source positioning, and visualization of the set-up geometry of the detector, its environment, and the weapon for MCNP computation. It is expected that any source and executable software code, documentation, user manual, and training developed under this subtopic be delivered to NIST.

9.06 INFORMATION TECHNOLOGY

9.06.01 Subtopic: Direct Digital Noise Measurement System

Present state-of-the-art noise measurements for rf carrier signals below 100 MHz use two phase-sensitive detectors, each consisting primarily of amplifiers, a phase-locked oscillator or delay line, a mixer, and filters, all of which are configured to convert phase fluctuations to voltage fluctuations. A cross-correlation spectrum analyzer then extracts the correlated frequency-domain voltage noise, which represents the noise of the device under test. Such measurement instrumentation is becoming increasingly important to standards laboratories, commercial systems-development programs, and production control.

It would be highly desirable to convert this analog signal processing to a digital system, essentially in a single processor. While state-of-the-art measurements might not be presently realizable, the trend toward faster digital signal processors and higher digital resolution indicates that the technology for realization of such measurements in digital form may well be at hand. For example, analog-to-digital converters (ADC's) operating at 120 Ms/s with 14-bit resolution are readily available. This digitizing rate and resolution translates to 100 MHz of useable signal bandwidth and quantization at the -84 dB level. The dynamic range on a per-Hertz basis is -84 dB - 10 log (BW) = -164 dB/Hz. If the rf carrier signal occupies a few Hertz of bandwidth and is 40 dB above the quantization level of the ADC, then there is 124 dB of dynamic range to characterize noise on the carrier. Faster ADC's and 16-bit resolution will be introduced in the near future, thus extending the capability of the direct digital approach.

This opportunity calls for a Phase I study of design options for digital noise measurement systems that might replace their existing analog measurement counterparts. Assuming that suitable designs are developed, the follow-on Phase 2 work would require construction, demonstration and delivery to NIST of a prototype digital noise measurement system. Proposals submitted under this subtopic may address access to NIST facilities for testing and characterization.

9.06.02 Subtopic: Pervasive Computing, Accessible Computing Technology Integration And Demonstration

Pervasive computing environments are emerging as portable and wearable computers, multi modal interfaces, and dynamic networking are employed together to mediate between users and their information infrastructure. The user interfaces will be distributed across numerous, small, portable, and embedded devices and must support multiple modes of transcoding to render them on displays at hand. Some devices may have exceedingly limited visual resolution, or none at all, requiring all output to be provided aurally. For example, some may have only visual capability, requiring audio to be transcoded to the visual mode, if possible.

The INCITS V2 committee is developing standards for user preferences to be provided to information appliances and environments that identify display and interaction modalities that a user or device can employ. For example, some users may prefer hands-free, ears-free, or eyes-free interaction modes. Multi modal pervasive environments offer an opportunity to accommodate to these user preferences. This will require the integration and management of numerous devices and capabilities using standards-based metadata describing device capabilities, user preferences, and transcoding standards for the data streams in question. A demonstration of these capabilities could include dynamic transcoding, like rendering text as speech and vice-versa, or preferences like minimum type fonts for readability, may now be technically feasible.

While many companies are developing stand-alone products, a real challenge lies in integrating products from different vendors into a single, functional, pervasive environment. The NIST Smart Space Laboratory has developed the NIST Smart Flow system, a reference platform allowing disparate devices and applications to work together. We believe that integration standards will help industry to bring pervasive computing components together into real and useful systems offering novel user services. The successful implementation of pervasive environments requires high bandwidth data transport to recognition, retrieval, and rendering algorithms running on distributed networks. NIST has defined a set of interface objects, and a transport mechanism, along with a reference implementation for TCP/IP networks using Linux based data servers. In this architecture, clients are linked and communicate with each other through data flows.

The goal of this topic is to investigate and demonstrate innovative techniques to make the office or meeting room of the future more accessible and productive, using the NIST Smart Flow software and technologies provided by various commercial vendors. Possible smart environments might include an accessible meeting room, or an advanced medical examination room.

Standards such as the INCITS V2 can be used to coordinate pervasive wireless devices, and multi modal sensor-based user interfaces. The combination can open new possibilities for assisting users with special mobility, or sensory mode preferences.

For example, a person who prefers not to operate a keyboard, could enter a pervasive environment wearing wireless devices that negotiate with the room to start hands free services for remote speech recognition, or gaze tracking. The person could carry his speaker training models to enable automatic transcription of what he says, parse it for commands, allow free text input for writing, or information retrieval. The document he dictates can be transmitted to his information appliances when finished; all completely hands free.

Capabilities to be incorporated into smart environments using the NIST Smart Flow system could include:

- Assistive technology such as a spoken interface using microphone arrays to allow speech input form anywhere in the room. An interface to transmit working documents, and biometric signatures such as voice patterns could allow voice input from a specific user, allowing others to freely converse but not be included in the voice interface.
- Service discovery capabilities allowing each user to have a personalized interface customized to his needs or wants.

During Phase I, the contractor will interact with NIST to explore, and demonstrate ways of using the NIST Smart Flow system and integrating various pervasive computing devices into a Smart Space environment to making technologies accessible using pervasive information appliances, and controlling flexible, personalized sensor based interfaces using metadata profiles, such as the INCITS V2 standard.

More Information about the NIST Smart Space Laboratory and the NIST Smart Flow system may be found at: www.nist.gov/smartspace

9.07 INTELLIGENT CONTROL

9.07.01 Subtopic: Laser Light Source For Illuminating Specularly Reflecting Droplets NCT PNGV

Understanding of several high-speed industrial metals processing technologies such as atomization or spray deposition would be greatly improved by high-speed photography, which requires a visible light source to illuminate rapidly-moving droplets. The particles and droplets generated by these processes are generally 5 um to 100 um in diameter and travel at velocities up to several hundred m/s. The specularly reflective surface of the metal droplets renders point source and collimated light unsuitable for the required reflected-light imaging of surface structure. A light source suitable for this purpose would need the capability to be synchronized with a high-speed movie or video camera (10,000 fps) where each frame could be exposed with one or more short duration (<100 ns) pulses, to create a flash illuminated image through telescopic/macro optics. An external sync oscillator connected to a copper vapor laser capable of 15 to 20 watts of light output with a fiber optic coupling to a beam expander and Lambertian scattering plate should provide sufficient brightness and dispersion for this application. Other laser or white light sources would be considered if the wavelength, pulse duration, power, and repetition rate were suitable for high-speed exposures. The awardee(s) will make a prototype system available to NIST during phase 1 for testing in a laboratory environment. NIST will collaborate with the awardee(s) on the tests.

9.07.02 Subtopic: On-Line, Non-Destructive Measurement Of Mechanical Properties Of Metals And Alloys NCT PNGV

Users of formed metals and alloys have a need to know the mechanical properties of their formed parts. This information is often needed on a part-by-part basis and statistical information is not sufficient. NIST research (J Appl. Phys., vol. 81, 4263, (1997)) has shown that the Barkhausen Effect is highly correlated with the mechanical properties of ferromagnetic materials, such as steel, providing the basis for a non-destructive method that might be used as a characterization tool of finished products such as automobiles to provide the needed information. This solicitation seeks the development of probes and associated equipment based on the above effect (or similar non-destructive effects) to demonstrate feasibility in the measurement of mechanical properties in a production environment. The device or system developed would be deliverable under phase 2. NIST will provide materials to the awardee(s) for testing the sensitivity of the device to changes in deformation.

9.08 MANUFACTURING SYSTEM INTEGRATION

9.08.01 Subtopic: Computational Tools To Support Intelligent And Distributed CAD

Design of complex engineering systems is increasingly becoming a collaborative task among designers or design teams that are physically, geographically and temporally distributed. The complexity of modern products means that a single designer can no longer manage the complete effort. Designers are no longer merely exchanging geometric data, but more general knowledge about design and design process, including specifications, design rules, constraints, rationale, and more. As design becomes increasingly knowledge-intensive and collaborative, the need for intelligent CAD tools to support the representation and use of knowledge among distributed designers becomes more critical. The objective of this solicitation is a development of computational software tools to support intelligent and distributed CAD (IDCAD), or more specifically, frameworks for distributed design that will improve the ability to represent, capture and reuse design knowledge, and to enable design integration across time and space. Examples of challenges associated with IDCAD include but are not limited to knowledge-based CAD, knowledge capture and sharing, supply chain management, Internet-based communication, novel design agents, etc. An emphasis will be placed on software tools that are either compatible with hardware/ software platforms used by small to medium enterprises, or accessible from such platforms (e. g., via the Internet). Delivery of the computer-based software tools developed under phase 1 would be expected. It is expected that NIST will collaborate extensively with awardee(s).

9.08.02 Subtopic: Integrated Process Modeling

The vision of "first part correct" demands a different approach in many areas of manufacturing engineering. New concepts such as predictive process engineering and science-based manufacturing will require a physics-based understanding of material removal manufacturing processes, advanced process metrology methods, valid analytical models to predict process performance and optimize manufacturing decisions, and rigorously-defined representations for manufacturing process information. There will be a shift from classical feedback quality assurance and optimization to model-based feed-forward process design and quality control. Product and process designers will have knowledge of and access to process specifications, manufacturing knowledge, and predictive process models to generate product and process designs seamlessly to produce the correct part the first and every time. To meet these needs, a number of areas are being addressed in parallel.

The existence and usability of process characterization models represent a central component of the first part correct vision. The process models describe the manufacturing process capabilities based upon proven theories and techniques, including analytically derived relationships, dynamic equations, empirical correlations, and statistical inferencing. Key issues include (1) validation of the process models to ensure accurate results and to instill confidence to potential users and (2) usability of the process models to integrate and incorporate these models into engineering applications throughout the product lifecycle where decisions are made. To improve manufacturing productivity and reduce lifecycle costs, appropriate mechanisms must be developed to enable use of manufacturing knowledge throughout the entire product lifecycle.

NIST is requesting proposals to address tools, methods, data representations, and/or prototype implementations for validation of physics-based process models for milling and turning operations and integration of these models to improve engineering applications. The focus of this effort will be on use of the process model as a tool, rather than viewing the model as an end-goal in itself. As part of this work, software modules will be created and supplied to NIST that will integrate with and extend the capability of the existing Process Integration Framework effort. This NIST activity is developing an integration framework and prototype agent-based software system to improve product design, manufacturing process planning, and machining execution through use of process knowledge from predictive models. Further, use of the current draft standard Process Specification Language (PSL) is strongly recommended. The awardee(s) will work closely with NIST staff who are developing relevant process models, PSL, and prototype implementations of the Process Integration Framework. During Phase I the awardee(s) will be expected to deliver software source code and initial demonstration capability in one or more of the areas indicated for proposal topics.

9.08.03 Subtopic: Manufacturing Data Exchange Standards Interoperability Testing Tools

Manufacturers attempting to solve Computer Aided Design (CAD) and Computer Aided Engineering (CAE) interoperability problems through use of the international Standard for the Exchange of Product model data standards (STEP) require objective technical means to assure the compatibility of commercial software applications. Similarly, commercial software vendors, seeking to satisfy their customers, seek the capability to test their STEP implementations during the development cycle. Software deployment pilot programs are an effective means to test implementations to information exchange standards. However, test pilots can not be effective unless tools are available to isolate sources of exchange errors. Once isolated, translator errors and incompatible interpretations of a specification may be rectified in order to improve the capability of the participating implementations.

NIST is soliciting proposals to provide the technical infrastructure software tools necessary to support STEP implementation interoperability testing trials and to realize STEP conformance testing services. The focus of this effort is in the following areas:

Computer Aided Design to Computer Aided Manufacturing - Numerical Control (NC) for Machine Tools.

Computer Aided Design to Computer Aided Engineering - Finite Element Analysis (FEA)

The result of this effort shall be written reference test case data and test metrics for exchange testing as well as software tools capable of validating that neutral exchange data meets the requirements of the specified standard. awardee(s) will provide development and documentationof prototype testing methods in phase 1. It is expected that NIST will collaborate extensively with awardee(s).

9.08.04 Subtopic: Next Generation Process Exchange Tools And Applications

As manufacturing companies move toward increased integration, there is a growing need to share process information in addition to product data. Software applications range from those that simply portray processes graphically to tools that enable simulation, planning, analysis, scheduling, and/or control of processes. In collaboration with industry and academia, NIST is developing a Process Specification Language (PSL) that will be common to all manufacturing applications, generic enough to be decoupled from any given application, and robust enough to be able to represent the necessary process information for any given application. Additionally, the PSL will be sufficiently well defined to enable exchange of process information among established applications.

NIST is requesting proposals for computer-based software tools to facilitate the use of the PSL for process modeling and process information exchange. Proposals should target the specification and design of generic PSL-based development and integration of software tools or software application extensions to existing manufacturing application software. Solutions could involve the development of translators or wrappers for exchange, or tools for creating and editing PSL presentations. Awardee(s) will provide software to NIST at the conclusion of phase 1. It is expected that NIST will work extensively with awardee(s).

References:

- Internet site: http://www.nist.gov/psl/
- Schlenoff, C., Knutilla, A., Ray S., "Unified Process Specification Language: Requirements for Modeling Process." NISTIR 5910, National Institute of Standards and Technology, Gaithersburg, MD, 1996.
- Knutilla, A., Schlenoff, C., Ray, S., "Process Specification Language: Analysis of Process Representations." NISTIR 6160, National Institute of Standards and Technology, Gaithersburg, MD, 1998.
- Gruninger, M. and Menzel, C. Process Specification Language: Principles and Applications, to appear in AI Magazine (may also be found at http://www.mel.nist.gov/psl/pubs.html)
- Ciocoiu, M., Gruninger M., and Nau, D. (2001) Ontologies for integrating engineering applications, Journal of Computing and Information Science in Engineering 1:45-60. Schlenoff, C., Gruninger, M., Ciocoiu, M., (1999)
- The Essence of the Process Specification Language, Transactions of the Society for Computer Simulation vol.16 no.4 (December 1999) pages 204-216.

9.08.05 Subtopic: Ontological Engineering Applied To Manufacturing System Integration Research

The Manufacturing Engineering Laboratory is soliciting proposals for the application of the principles behind ontological engineering towards the area of manufacturing systems integration and/or research. The result of this effort will be mechanisms, infrastructures, and/or methodology tools with an ontological underpinning that will facilitate the interoperability of manufacturing systems. Within the former area, these principles may be applied to information that is to be shared among manufacturing applications, including, but not limited to, process, resource, product, and design information. Special emphasis will be given to proposals that are applicable to multiple types of information.

In the context of this proposal, an ontology is an explicit treatment of some topic as a written report. Included in this report would be the ontological formal and declarative representation, which includes the vocabulary (or names) for the terms in that subject area and the logical statements that describe what the terms mean and how they can or cannot be related to each other. The report should reflect that ontologies provide a formal means for representing and communicating knowledge about some topic and a set of relationships that hold among the terms. Without these formal and concise definitions of attributes, relations, and concepts, usually built upon some type of foundational theory, integration of manufacturing applications runs the risk of misinterpretation of those concepts, leading to problems with interoperability and exchange. Awardee(s) will provide reference test case data and test metrics in phase 1. It is expected that NIST will collaborate extensively with awardee(s).

References:

- Knowledge Sharing Effort, Internet site: http://www.cs.umbc.edu/kse/.
- Ontolingua Server Project, The, Internet site: http://ksi.cpsc.ucalgary.ca/KAW/KAW96/farquhar/farquhar.html.
- Plan Ontology Project, Internet site: http://www.aiai.ed.ac.uk/~bat/ontology.html.
- Process Interchange Format, Internet site: http://ccs.mit.edu/pif/.
- Toronto Virtual Enterprise Project, Internet site: http://www.ie.utoronto.ca/EIL/tove/ontoTOC.html.

9.08.06 Subtopic: Testability Of Complex Manufacturing Software Systems

Software systems used in manufacturing enterprises are large and highly complex. Manufacturers must integrate these software systems such that they dynamically interact with one another using standards interfaces. Those involved in these integration efforts are frustrated by the lack of practical testing methods for these interacting software systems, by the ineffectiveness of existing testing tools, and by the lack of consideration for testing that standards-developers employ when developing standards in this domain.

NIST is soliciting proposals to identify and develop software tools and written techniques for specifying, locating faults in, and testing conformance of interaction-driven manufacturing systems as well as developing and documenting methods for designing integration specifications with improved testability. The results of this effort shall be the development and documentation of prototype testing methods, leveraging existing ITL methods where appropriate, and the development of corresponding software tools. Proposers should identify in their documentation the characteristics of "testable" implementations and devise specification methods applicable to integration specification developers. Awardee(s) will provide software to NIST at the conclusion of phase 1. Proposals submitted under this subtopic may address collaboration with NIST staff.

9.09 MICROELECTRONICS MANUFACTURING

9.09.01 Subtopic: Calibration Methods To Remove Probe Shape Effects From Scanned Probe Microscope Measurements Of Semiconductor Linewidth

Scanned probe methods have great potential for measurement of linewidth in semiconductor manufacturing because these techniques are very short range. Therefore, they could in principle perform linewidth measurements with nanometer level resolution, significantly better than that of optical or scanning electron microscopes. However, the measurement of linewidth in semiconductor manufacturing is limited by knowledge of the shape of the probe tip, which cannot be characterized without adding significant uncertainty to the width measurement. A method is needed to remove probe shape effects from semiconductor linewidth measurements performed with scanned probe systems. This method would greatly reduce or eliminate the need for probe characterization and significantly improve the uncertainty of linewidth measurement and likely other length measurements at nanometer level scales. Of particular interest are innovative calibration methods for AFMs that remove the probe width from critical dimension measurements. Ideally, the method would not require the use of a calibration artifact. It is also important that the calibration method be capable of adjusting for probe shape changes in situ in between stages of a measurement process. The algorithms and software (including source code) resulting from the project must be made available to NIST for testing and implementation. At the end of phase 1, the awardee(s) will be required to demonstrate a technique for eliminating probe shape effects in scanned probe metrology and deliver the mathematical algorithms, software, and source code used to implement those algorithms. Proposals submitted under this subtopic may address collaboration with NIST staff or measurements to support the research.

9.09.02 Subtopic:Dielectric And Magnetic Ceramic Materials For LTCC Tapes

The primary technology drivers for wireless consumer devices and computer applications are miniaturization, higher frequency, lower operating voltages, reduction of component part count, and increased functionality. For example, multiband wireless telephones will require the packaging of two or three radios within the same cell phone format. One solution to this challenge is Multilayer Ceramic Integrated Circuit (MCIC) technology, which organizes the components into a single module containing all the passive and active components. MCIC technology requires ceramic dielectric materials which may be co-fired below 900°C with high-conductivity metals; i.e., low temperature co-fired ceramics (LTCC). Commercially available LTCC tapes are currently limited to non-magnetic dielectrics with low dielectric constants ($K < 10$) and quality factors. As a result, their use is generally limited to supporting or spacer layers. The successful development of embedded functional layers such as capacitors, filters, resonators, isolators, and circulators requires LTCC tapes of ceramic materials with a variety of K values (i.e. 100, 80, 40, and 20), temperature stability, and good Q (= Quality Factor or low dielectric loss). For isolators and circulators, the ceramics must also be ferromagnetic and display high magnetic Q. In all cases, viable materials must fire below 900°C in addition to exhibiting the required dielectric and magnetic properties. Closely related to the need for materials to expand LTCC tape functionality is the need for micro-methods to evaluate the dielectric and magnetic properties of embedded functional layers after firing and before circuit assembly. Current diagnostic capabilities are limited to evaluation of bulk samples of the functional materials or the final assembled circuit, rather than in situ characterization of functional layers.

To summarize, Innovative solutions are sought to define and develop materials leading to commercial LTCC tapes for embedded capacitors, filters, resonators, isolators, and circulators.

9.09.03 Subtopic: High Throughput Modification Of Wide Bandgap Semiconductors For Device Performance Optimization NCT

Wide bandgap compound semiconductors and their alloys find increasing application in optoelectronic (LED's, lasers, detectors) and microelectronic (high-temperature, high-power, and high-frequency transistors) devices. However, the performance of such devices is limited by several materials and engineering problems, including a difficulty in making thermally stable low-resistance electrical contacts to wide bandgap semiconductors. Achieving low contact resistivity is hindered by the energy barrier formed at the metal/semiconductor interface, and depends on several factors including the sheet resistivity of the semiconductor wafer and metallization composition. Reduction of sheet resistance and the optimization of the heat treatment schedule as well as the best metallization composition requires extensive experimentation in a multi-parameter space as well a method to organize this information for future reference. Thus, the methods of high throughput research (combinatorial materials science) are ideal for this problem.

The awardee(s) is expected to develop a system to produce libraries of materials for optimizing wafer sheet resistivity, based on the current state-of-the-art. Phase I results are expected to demonstrate the feasibility of the newly developed technique to produce sample libraries with continuous or discrete variation in sheet resistivity as applied to wide bandgap semiconducting materials of various types, as well as delivery of prototype wafers to NIST for testing and evaluation. Development of a system for automated sample preparation to facilitate subsequent measurement of electrical and electronic characteristics, as well as composition in each element of the array, is expected. The ability to modify semiconductor wafer properties at elevated temperatures, thus avoiding post-processing heat treatment step, is also an important issue. Awardee(s) will provide test samples for NIST to examine for library quality during the ongoing research.

9.09.04 Subtopic: Improved Magneto-Optical Indicator Films NCT

The magneto-optical indicator film (MOIF) imaging technique[1] is a non-destructive method for real time characterization of magnetic domain structure for a wide range of technologically important magnetic materials such as spin-valves, ultrathin multilayers, and granular systems. The MOIF film is placed on top of a magnetic sample and has its magnetization altered by the magneto-static field of the sample under study. In this way, the domain structure of the sample under study is imaged in a polarizing microscope through the interaction of the polarized light with the MOIF film. The MOIF method is expected to become a standard non-destructive quality control imaging technique for the next generation of magnetic materials for sensors and storage devices. Proposals are solicited for the development of improved magneto-optical indicator films, including , but not limited to, transparent Bi-substituted yttrium-iron garnet single-crystal films (thickness 1-3 micrometers, Faraday rotation > 100,000 deg/cm) grown on a gadolinium-gallium garnet substrate with a high reflectivity underlayer. The influence of different element substitutions should be studied to enable different magnetic saturation values and coercivities to be fabricated. Proposals submitted under this subtopic may address collaboration with NIST for the purposes of material testing. Successful recipients of a phase 2 award will be expected to provide a prototype to NIST.

Reference:

- V.S. Gornakov, V.I. Nikitenko, L.H. Bennett, H.J. Brown, M.J. Donahue, W.F. Egelhoff, R.D. Mc.Michael and A.J. Shapiro. "Experimental Study of Magnetization Reversal Processes in Nonsymmetric Valve." J. Appl. Phys. **81**. (8) 5215.

9.09.05 Subtopic: Rapid Thermal Annealing System With Temperature-Time Gradient

Short-time annealing or rapid thermal annealing (RTA) is a common and important step in processing electronic materials into device structures. RTA is employed to improve crystallinity and to modify electronic properties of thin film and bulk crystals, to bond layers of different materials (metal to metal, metal to ceramic), and to clean or modify film surfaces by thermal evaporation, oxidation, nitridation, etc.

NIST is developing a combinatorial methodology for processing and characterization of thin film electronic materials. It involves RTA process optimization for specific experimental setups with a variable space that includes annealing temperature, time and ambient gas. The limitation of present industrial and laboratory RTA systems is that they only provide uniform temperature distribution across the whole annealing chamber at any given time, and do not allow variation of either temperature or time of annealing as a function of specific position in the chamber. This limits throughput of experimentation and testing ability to study effect of temperature-time gradient across the combinatorial array of samples.

We are requesting proposals to develop and to deliver an RTA system with temperature-time gradient capability. The system should provide independent control of both annealing temperature and annealing time across the chamber. The RTA system with integrated PC controller is required to meet the following specifications: 1) controlled (programmable) temperature gradient in the test samples up to 10 degrees/mm in at least one direction on a length scale of up to 150 mm, 2) controlled time of annealing in the range from several seconds to several minutes along the same direction(s) in the chamber, 3) multiple points accurate temperature monitoring across the sample with the ±3oC accuracy and ±1oC precision; 4) multi-gas capability allowing heat treatment of the samples in various gas mixtures, 5) accommodating large size samples (up to 150x150 mm square samples or 6" wafers) for combinatorial studies.

Phase 1 results are expected to demonstrate the feasibility of the newly developed prototype RTA system to produce and to monitor the temperature-time gradient on 2" metal coated ceramic test wafers supplied by NIST.

It is expected that at the end of Phase 2 the awardee(s) will manufacture and deliver the prototype RTA system (device and controls) to NIST facilities. NIST plans to communicate with the company during the project, provide test samples for the company to do the test annealing runs to ensure the specs described in the sub-topic are met. It is expected that NIST will collaborate with awardee(s) by providing test samples for annealing runs.

9.09.06 Subtopic: TEST METHODS FOR EMBEDDED PASSIVE DEVICES

Innovative modeling and testing procedure are sought to characterize properties of embedded passive materials in planar film configuration and to determine the nominal electrical impedance values of the corresponding devices. In contrast to the traditional discrete chip devices, which mechanical and electrical characteristics can be measured prior to assembly using known standard testing procedures, characterization of EPDs that are created and assembled in the same step, is much more complex. Once such devices are fabricated they are not repleaceable and typically difficult to rework.

Microscale measurements of mechanical and thermal properties of multi-component structures is critical to the understanding and modeling of reliable designs. Measurements of the thermal expansion mismatch of materials in small-scale microelectronic packages require advanced techniques such as electron-beam moiré interferometry.

The success of the new technology will ultimately depend on availability of appropriate testing procedures to determine electromagnetic responsiveness and impedance characteristics of EPDs at microwave frequencies, above 1 GHz, where they behave as distributed rather than lumped components. The primary focus is on developing testing procedures to characterize terminating resistors and decoupling capacitors with tolerances of 5 % to 1 %. A number of diverse composite materials has emerged for EPDs, where each material imposes various tolerance due to specific fabrication conditions and uniformity of material, such as thickness, resistivity and dielectric permittivity. Depending on the type of material used, the inherent process tolerances will be a sum of all those factors. Consequently, tolerances of less than 10% are challenging for the industry today. Nevertheless, laser trimming techniques coupled with appropriate testing can provide tolerances to better than 1 %, regardless of the material used. Therefore, new standard procedures and equipment are needed for testing passive components on the inner layers while giving active feedback from trimming. Methodologies based on non-sinusoidal measurements, such pulsed current technique and time domain reflectometry seem to be preferred, since they are capable of satisfying both, the high-frequency requirements and compatibility with the robotic-automated hardware already installed on the manufacturing floors. Awardee(s) will use NIST procedures, software, and equipment, and work collaboratively, to learn how to perform testing and characterization, and to learn how to interpret their own data. Awardee(s) will manufacture a meaningful test structure and will provide the test structure to NIST for fundamental evaluation.

9.10 MICROFABRICATION AND MICROMACHINING

9.10.01 Subtopic: Development Of Meso Scale Machine Tools

The micro-meso fabrication market is expanding to meet the demand for increased functionality, reliability and performance for smaller components that are frequently used in optoelectronics, medical equipment, sensors, communications, aerospace and automotive industries. In manufacturing of micro-meso products, machining has significant advantage in being able to generate three-dimensional complex shapes out of wide range of materials. In addition to being very agile, machining is also able to produce high accuracy and surface finish compared to other manufacturing methods. Therefore, meso machine tools are clearly one of the most important enablers in micro-meso manufacturing. Improvements in machine tool technologies are tightly coupled with the development of proper metrology tools and methods as evidenced by the improvements in CMMs and conventional machine tools.

NIST is currently exploring the metrology challenges and opportunities for such machines. The metrology challenges include 1) the required dramatic improvements in machining accuracy, 2) the lack of space for metrology components, 3) the difficult application of process-intermittent inspection due to the small feature sizes, and 4) the difficulties in achieving repeatable part fixturing, requiring multiple operations in one setup. The small work volume required by the machining applications, however, also presents unique opportunities for the application of superior metrology concepts that radically depart from classical machine tool metrology.

In order to facilitate these efforts, NIST is seeking proposals to design and develop innovative multi- axis meso-scale machine tools that would serve as test platforms for developing and evaluating new metrology tools and concepts as well as research in micro-meso scale machining. The machine that is of interest would have a work volume of 50 mm cubed or less. The proposed work should involve prototype development. At the end of Phase 1, delivery of the prototype multi-axis motion platform to NIST for further metrology research is expected. Phase 2 effort would build upon this platform to integrate additional axes, spindle and work holding devices and other auxiliary devices to enable machining of meso scale components.

Proposals that emphasize low cost and innovative structures, drive/actuator, metrology and sensing technologies while addressing the challenges mentioned above are strongly encouraged. Proposals responding to this subtopic may address collaboration with NIST, and in phase 2 use of the NIST test bed for testing and characterization.

9.10.02 Subtopic:Improvement Of Sensing Head For Quantitative Nanotribology Measurements

Advances in microelectromechanical systems and hard disks require careful control of nanomechanical properties especially adhesion and friction at the nanometer scale. This proposal solicits development of a sensing head for quantitative measurements of frictional forces at both nanometer and micrometer scales. The cantilever method commonly used in current friction force microscopes (i) lacks stiffness, (ii) has large coupling between vertical and horizontal motions, and (iii) is very difficult to calibrate. Recently published designs [see Sensors and Actuators 84 (200) 18; Physical Review B 65 (2000) 235429] have improved stiffness and reduced coupling between vertical and horizontal motions. Novel sensing-head design and development, which (a) solve all three problems mentioned above, (b) are capable of measuring frictional forces in the nanonewton range with resolution and accuracy of 5 nN or better, (c) are capable of probe-sample distance control of 0.3 nanometers or better, and (d) are reliable and relatively easy to use, are solicited.

Phase I should demonstrate the feasibility of a sensing device to meet the stated criteria and, for that purpose, delivery of a prototype device for evaluation is required. The objective of Phase II is the delivery of a fully functioning sensing device that meets all the criteria.

Collaborative work between NIST and the company is anticipated in the sense that the devices will be tested and evaluated by the company and by the NIST staff, and the evaluation results will be made available to the company so that the device can be improved. It is expected that NIST will collaborate with awardee(s) in that NIST will test, evaluate, and provide feedback on devices.

9.10.03 Subtopic: Measurement Of Small Structures

There are an increasing use of small, sub millimeter structures (particularly holes) in a number of very different manufacturing areas, including optical fibers (ferules), automotive (fuel injectors), and electronics (microwave attenuation standards). While the measurement of the top of the hole can be made optically, even here there are unresolved problems with diffraction. The measurement of geometry down in the hole, a critical measurement for most applications, is not possible optically. We have made such measurements on holes slightly smaller than 0.7 mm in diameter using special probes with stiff ceramic stems. The technology cannot, at this time, be pushed below 0.5 mm.

The goal of this research will be to develop a probing system to measure very small holes, down to 50 micrometers, with aspect ratios (height to diameter) greater than 5. The probe should have resolution of 1 nanometer and repeatability of 10 nanometers or better. The Engineering Metrology Group at NIST has a coordinate measuring machine which can provide motions in X, Y and Z with 10 nanometer control, and the sensor could be used with this machine or other commercial coordinate measuring machines used for small feature measurement. The impact of developing such a system is expected to be broad and highly infrastructural. Awardee(s) must deliver a prototype sensor system for testing to NIST in phase 1, and a fully useable, documented system in phase 2. It is expected that NIST will work collaboratively with awardee(s)

9.11 OPTICS AND OPTICAL TECHNOLOGY

9.11.01 Subtopic: Femtosecond Lasers For Optical Comb Generation

Femtosecond mode-locked lasers have already become critical to the synthesis and measurement of optical frequencies, but they are also being applied in emerging technologies as diverse as secure communications, navigation, length measurement, and atomic clocks. The prototype laser systems that have been applied to these areas were not developed for the specific applications, and there is now a clear need for a new generation of lasers, which have been specifically tailored to the generation of optical (frequency) combs. The system requirements for such lasers include (1) a solid opto-mechanical design, assuring stable, long-term operation; (2) very low frequency-modulation noise and amplitude-modulation noise; (3) inputs for precise control of both pulse repetition rate and carrier-envelope offset frequency (f0); and (4) a broad spectral bandwidth that allows reliable detection of f0 with a high signal-to-noise ratio (>30 dB in a 300 kHz bandwidth) and simultaneously reliable detection of beatnotes with continuous-wave optical frequency standards with a high signal-to-noise ratio (>30 dB in a 300 kHz bandwidth). Desirable characteristics include a high repetition rate (>200 MHz), operation with a commercially available pump source, compact size, and good electrical-to-optical power efficiency.

While proposals should emphasize innovative concepts that simplify the process of comb generation, the criteria for proposal evaluation will focus largely on the anticipated performance characteristics. Should work proceed to Phase 2, a prototype femtosecond laser that meets the requirements of this application will be the key deliverable. Access to specific NIST facilities will be provided to the extent that it is required for testing/characterization.

9.11.02 Subtopic: Growth And Characterization Of II-VI Semiconductor Crystals For THz Detection And Generation

As spectroscopy in the THz region of the region of electromagnetic spectrum is developed, there is increasing need for reliable high-quality nonlinear crystals such as ZnTe and GaP suitable for generation and detection of THz radiation. Currently, there is high variability in the performance of crystals from different vendors, and even from a single vendor. The most critical parameters relative to THz spectroscopy are the transmittance of in the THz spectral region and the spatial uniformity of that transmittance. We solicit a program to systematically study ZnTe and GaP crystal growth parameters with the goal of learning how to reliably produce high-transmittance crystals. In addition, it is important to be able to produce crystals with thicknesses of a few millimeters to as thin as tens of micrometers. The studies should include investigations of reliably sizing the thickness while maintaining the appropriate characteristics relevant to producing and detecting THz radiation. While the focus should be on these crystals, other crystals relative to THz spectroscopy may be included, e.g. GaAs. NIST will work with the vendor by providing the capability to measure THz spectral transmittances. The vendor will provide NIST with all samples, growth parameters, and conditions used for each crystal produced under this project.

9.11.03 Subtopic: Solid State Radiometric Sources For Remote Sensing

Innovative proposals are requested for narrow-band, incoherent, solid-state light sources to replace conventional quartz-halogen and arc lamp standards to aid the calibration of satellite, air, and ground sensors used in global climate change research, intelligence gathering, and military targeting. Present lamp sources often yield unacceptably large sensor-calibration uncertainties due to low levels of ultraviolet flux and the poor spectral match between the calibration source and the radiation source to be measured by the sensor.

The rapid advances in solid-state lighting technology, including recent developments in Light Emitting Diodes (LEDs), Organic Light-Emitting Diodes (OLEDs), and Light-Emitting-Polymers (LEPs), motivates the present solicitation. Solid-state light sources are of interest at NIST for calibrating a variety of radiometers and other optical sensors. The expected advantages of solid-state light sources for calibrating radiometers include the ability to tune the relative spectral distribution to better match natural radiation sources, such as the solar illuminated ocean and desert, reducing or eliminating the often dominant calibration uncertainty from scattered light, and increased ultraviolet radiation output, at a level commensurate with solar and reflected solar sources, to better assess radiometer linearity and dynamic range. Solid-state standards also promise lower power consumption and, correspondingly, a more benign thermal environment, providing the potential for deployment in the field (on aircraft, ships, and at remote desert locations) and in space (on remote sensing satellites). Ideally, solid-state sources would be available in 5 nm increments over the full spectral bandwidth from 360 nm to 1000 nm (and beyond) and have spectral bandwidths of 10 nm to 20 nm. The lack of solid-state sources near 550 nm is particularly problematic as it limits our ability to design a fully tunable, incoherent, solid-state light source.

Successful completion of a Phase II effort will require the development and delivery of six narrow-band solid state sources (LEDs etc.) in a spectral region that is not commercially available, such as near 550 nm, for testing and evaluation at NIST.

9.11.04 Subtopic: Tunable Lasers For Molecular Spectroscopy

Water and other contaminants in phosphine, arsine, silane, ammonia and similar gases create serious manufacturing yield problems when these gases are used in the epitaxial growth of high purity semiconductor layers. NIST has a program for improving detection of water as an impurity in these gases that would greatly benefit from the existence of tunable lasers near the strong water absorption bands. The optimal efficiency would be for lasers with emission wavelength centered on 1380 nm with high stability (less than 100 kHz short-term drift), at least 10 mW power output, and mode-hop-free tuning range greater than 10 GHz. We are requesting proposals to develop novel tunable laser configurations that emit in this wavelength region and to test the suitability of these systems as a light source relative to the performance of a conventional external-cavity tunable laser system. Phase 2 research should include the delivery of a prototype tunable laser to NIST.

9.12 RADIATION PHYSICS

9.12.01 Subtopic: Two Dimensional Detection Of Neutrons With High Spatial Resolution, High Dynamic Range And Low Noise

The NIST Center for Neutron Research (NCNR) operates a 20 MW research reactor including a cold neutron source. The reactor provides a peak thermal core flux of 4x10^14 neutrons/cm2/sec for use in materials and science research. Approximately fifteen instruments use the cold neutron source and another six use thermal neutrons.

New concepts are needed to advance the state-of-the-art in spatially-sensitive detection of thermal neutrons. In particular, we seek detectors that cover large solid angles (concave cylindrical or spherical geometries are advantageous). The ideal would be a detector that covers 4 pi steradians with 5000 x 5000 channels, but a detector with 0.5 mm x 0.5 mm spacial resolution and 1000 x 1000 channels would offer a significant improvement in the state of the art. The eventual detector design must allow quantitization of neutrons fluence from 0.1-10,000 neutrons/cm2/sec in a background of 10,000 gamma photons/cm2/sec and will be read with no manual intervention.

The awardee(s) will be afforded access to beam facilities at NCNR for testing and NCNR staff will be available for discussions. The expected outcome from a successful Phase 1 award will demonstrate the possibility of multiple pixel detection of neutrons and the expected outcome from a Phase 2 award is a prototype 2-D detector that will be provided to the NCNR.

9.13 TECHNOLOGIES TO ENHANCE FIRE SAFETY

9.13.01 Subtopic: Advanced Building Information Systems

Modern buildings have fire detection systems that provide information from detectors in the building to fire alarm panels. These nodes and display units are generally located in a location designated as the fire fighter entry for the building. Current use of such systems is focused on identifying nascent fires such that warnings can be provided prior to loss of life or extensive damage. However, the most effective use of resources for firefighting and occupant rescue requires that the location and size of the fire be determined as well as the initial indication of such events and that information be made available outside of the building. If this information could be provided directly to the fire services, both dispatch and in a vehicle, it would improve the efficiency and safety of their operations. This presents a major opportunity for the introduction of new products that improve efficiency for the fire fighting community. Of particular interest are neural networks for early detection and rejection of false alarms (using current or new transducers), mathematical techniques that provide data fusion from multiple sensors, scalable technologies that provide prioritized "data-out" service over a wide variety of communication paths, and display schemes which conform to the new NFPA 72 Chapter 4 guidelines and are accessible over small footprint displays.

Proposals for incremental advances to existing fire detection are not solicited; however, proposals that address only a portion of this research are welcome. Expected deliverables to NIST include: a feasibility algorithm as a working example at the conclusion of Phase 1, and should Phase 2 be awarded, a working example device. NIST anticipates acting in an advisory capacity and in providing model data sets and standard fire test data.

9.13.02 Subtopic: Distributed Multi-Nodal Voice/Data Communication For Fire Fighters

Fire ground communication between fire fighting teams and between teams and incident command typically utilize hand held radios. Hand held radios may provide adequate communication when both parties are outside of buildings, but as a fire team moves inside a structure, the ability to communicate tends to degrade quickly. This is especially evident if the walls of the structure contain significant amounts of metal. Metal, such as aluminum siding or the aluminum facing on insulation, can be sufficient to prevent VHF, UHF, and ultra-wide band radio transmission. Research is required to determine if a series of distributed nodes could be used to relay both voice and data communications. . Each node would have to be capable of receiving information from other nodes and then be able to relay that information out to other nodes until the information is communicated to the incident command that is typically located outside the structure. Each node would have to be able to "see" or maintain radio contact with other nearby nodes. This series of nodes need to be able to compensate if one or more nodes are suddenly removed from the network by thermal damage or structural collapse. The nodes will include voice communication between individual team members inside the structure, but can also communicate with incident command. The nodes will also link the fire teams and incident command for the transfer of data, such as "fire fighter down" or PASS device alarms. This technology could be incorporated into existing fire fighter equipment, such as hoses, turn-out gear, extinguishers, helmets, Personal Alert Safety Systems (PASS), or self-contained breathing apparatus. The nodes could also take the form of small deployable packages that are distributed by a fire fighter, by insertion into a room through a closed or open window, or by radio controlled insertion robotic devices. However, each node must be extremely lightweight, including power source, in order not to burden the fire fighter with significantly more weight.

Proposals for incremental advances to existing radio technology are not solicited; however, proposals that address only a portion of this research are welcome. Phase I will demonstrate feasibility. In Phase II, a functioning group of nodes will be delivered to NIST.

9.13.03 Subtopic: Enhanced Fire Fighter Visibility

In response to structure fires, fire fighters typically enter structures to locate possible victims or conduct fire suppression. Structure fires often produce sufficient smoke to make it hard for fire fighters to maintain contact with each other. Research is required to determine if technology can allow fire fighters to maintain contact with other fire fighters in hot, steam and smoke filled rooms. This contact could be visual, such as a strobe light tuned to that part of the spectrum visible by thermal imagers or infrared cameras, or it could be acoustic, such as a system that emits a series of beeps when a fire fighter is aligned with another fire fighters. The frequency of the beeps or strobe flashes could increase as a fire fighter moves closer to a second fire fighter. The technology needs to provide sufficient information to the fire fighter so that the location of the second fire fighter can be quickly and correctly ascertained. This technology must be able to not alert a fire fighter that a second fire fighter is in the smoke filled room, but must be able to indicate whether the second fire fighter is to the front, rear, left or right side, of the first fire fighter. The system should also be able to handle multiple fire fighters so that if there are four fire fighters in a room, that each can understand that there are four separate fire fighters in the room. The technology used to maintain contact should not require the use of the hands of the fire fighter who is already carrying other equipment, such as hoses, axes, or extinguishers. This technology could be incorporated into existing fire fighter equipment, such as hoses, turn-out gear, extinguishers, helmets, Personal Alert Safety Systems (PASS), or self-contained breathing apparatus. The technology needs to be extremely light weight so to not burden the fire fighter with significantly more weight.

Proposals for incremental advances to existing reflective markers for protective gear or light sources are not solicited; however, proposals that address only a portion of this research are welcome. Phase I will demonstrate feasibility. In Phase II, a functioning system for eight fire fighters will be delivered to NIST for further study.

9.13.04 Subtopic: Sensing For Advanced Warning Of Structural Collapse

One of the major risks to firefighters in burning structures is that the fire will have weakened portions of the structure. Many firefighters are killed each year when a structure give way beneath them or a portion of the structure falls on them. This occurs most often in house fires. Fire incident commanders need to have reliable means to assess whether or not a structure is safe for firefighters to enter or remain inside performing search and rescue and fire fighting activities. NIST seeks a practical device that can be used to reliably assess the structural integrity of burning houses. The sensing device needs to be self-powered and send warning alarms to command locations on the site. If physical contact with the structure is required, the sensing device needs to be readily mounted by firefighters. Information about the expected sensitivity to partial collapse and amount of early warning provided for escape before collapse of the sensing device need to be documented. The contractor will make a prototype device available to NIST for evaluation. Human or animal testing should not be part of this research. Those submitting proposals should be aware of research performed by Professor Ziyad Duron at Harvey Mudd College in Claremont, California to use the natural fire induced vibration of a structure as means to provide advanced warning of structural collapse.

9.14 X-RAY SYSTEM TECHNOLOGIES

9.14.01 Subtopic: Develop Advanced X-Ray Detection System For Nanoscale Measurements

The new x-ray spectrometers based upon the silicon drift chamber principle can have large detection areas of many square centimeters. This detection area exceeds considerably the solid collection area of current energy dispersive x-ray detectors used on Analytical Electron Microscope (AEM) systems. AEMs are one the major analytical instrument used to characterize nanotechnology devices. It is expected that this increased detector area will allow a factor of 5 to 10 improvement in sensitivity in the AEM. The successful detector system shall have active dimensions of approximately one by three centimeters, operate over the full range of energy dispersive x-ray energies (approximately 0.3 to 20 keV), and have a resolution of 150 eV or better (Mn k-alpha). The detector system may be multiplexed. The single or suite of detector chips must fit inside the AEM specimen chamber. The detector design must be compatible with the cold trap and other specimen area devices in the AEM. The detector shall be compatible with either the Philips (now FEI) CM30 or CM300 TEM/STEM at NIST. A design encompassing all necessary detector and AEM physical, electronic, cooling, counting system, and x-ray systems will be completed for Phase I. A prototype detector will be delivered to NIST by the end of Phase 2.

9.14.02 Subtopic: Large Area Imaging Two-Dimensional Electron Energy Analyzer

NIST seeks the design and construction (delivery of prototypes) of a practical large area imaging two-dimensional electron energy analyzer for materials science applications of soft x-ray absorption spectroscopy at our synchrotron radiation facilities (200 to 1200eV). We utilize polarized soft x-rays as a searchlight for chemical bond identification, orientation and quantification by measuring Near Edge X-ray Absorption Fine Structure (NEXAFS). Currently, electron yield NEXAFS utilizes a single channel electron multiplier detector housed in a shield tube positioned behind a three-grid electrostatic high pass energy filter. NIST has begun to utilize this method to produce NEXAFS chemical images (chemical bond concentration and orientation) of macroscopic (50 mm) gradient monolayer surfaces. These images are acquired in a serial fashion, which takes a long time, limiting sample throughput and the effective utilization of our synchrotron radiation facilities. Furthermore we are limited to acquiring data in only one dimension.

Thus, we seek a new parallel process large area imaging two-dimensional electron energy analyzer for acquiring NEXAFS images on a rapid time scale. The large area imaging two-dimensional electron energy analyzer should be able to image an area of at least 10mm by 10mm, (preferably twice that) with good energy and spatial resolution. An electrostatic energy analyzer is preferable; the typical electron kinetic energy is 50 to 900eV tunable. The delivery and testing of prototypes at NIST synchrotron facilities can be possible in cooperation with NIST personnel.

The successful development of a practical large area imaging two-dimensional electron energy analyzer would be a very significant advance in the application of soft x-ray absorption spectroscopy at synchrotron research facilities in the United States. Soft x-ray absorption spectroscopy is a valued analytical tool for companies and academia and is routinely applied for creating chemical depth profile maps of polymer surfaces, photoresists and other materials problems.

In a broader context the successful development of a large area imaging two-dimensional electron energy analyzer would be a very significant advance in X-ray Photo-emission Spectroscopy (XPS) imaging. Currently, imaging XPS is often limited to one-dimensional analysis or relatively small analysis areas. Large area imaging two-dimensional electron energy analyzers would provide an important practical improvement in XPS systems found in many analytical and researches laboratories throughout the United States.

9.14.03 Subtopic: Vacuum Windows For Third Generation Synchrotron Radiation Beamlines

The NIST bending magnet beamline at the Advanced Photon Source (APS) requires a minimum of three vacuum windows to separate the experimental beamline from the ring vacuum as well as to segregate beamline components from each other. These windows are part of the x-ray optical system and effect the x-ray beam quality through the introduction of phase contrast due to local variation in the refractive index. They also reduce beam intensity through absorption. To improve the performance of these beamlines, improved windows are needed that address these two areas. The highest priority is the elimination of phase contrast. Specifically, new windows must have improved specifications for surface finish and thickness uniformity, but must not introduce any other spatial variation in the beam intensity. It is expected that a minimum value for surface roughness of 0.01 μm r.m.s. and a peak-to-valley variation of less than 0.1μm will be required. The second priority is to reduce absorption. The existing 0.25 mm thick beryllium windows attenuate the beam in the lower energy range around 4 - 5 keV. The improved windows should have increased x-ray transmission at this energy compared to 0.25 mm thick beryllium. The windows must withstand illumination by the full white spectrum from the source, but can be actively cooled. They must also meet all requirements imposed by the APS for window integrity and must be integrated into the existing beamline hardware. The dimensions of one window must be at least 8.8 mm x 145 mm, a second window must be at least 12mm x 145 mm and a third window must be at least 40 mm x 150 mm. Awardee(s) will be required to deliver a prototype vacuum window to NIST in phase 2. It is expected that NIST will collaborate with awardee(s) on the definition of design parameters consistent with the limitations imposed by the existing NIST system. It is expected that awardee(s) will need access to the NIST beamlines so that new components can be integrated into the beamline.